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A SUIT TO PREVENT THE DIVERSION OF SEWAGE from the Park River, at Hartford, Conn., has just been decided in favor of the city by the Supreme Court of Connecticut. The city is constructing an intercepting sewer to divert sewage from the river within the city. It is stated that the sewer is nearly ready for use, and that it has cost about $250,000. The suit was brought by the owners of a dam below the old sewer outlets, who claimed the city had no right to diminish the flow over their dam by divert-sewage from the stream, and asked for an injunction to prevent the diversion. The court holds that if the plaintiffs have any claims against the city they relate to the diversion of the water from the stream for the city water supply, in which case they should either ask for damages on that account or demand the return of the water to the stream in its original amount and purity. Having diverted the water and converted it into sewage, the city has a right to dispose of that sewage as it sees fit, so far as rights pertaining to the original water are concerned. The construction of the intercepting sewer is the outcome of years of agitation, accompanied by many complaints regarding the offensive pollution of the river, and, if we remember rightly, suits as well as complaints.

A JOINT OUTLET SEWER for Colorado Springs and Colorado City has been authorized by the city council of Colorado Springs in the form of an approval of an agreement for the joint construction of the sewer. If carried out, as seems probable, this will be the first joint sewer outlet built in the West, so far as we know, although they are being constructed to great advantage in many places in the New England and Middle States.

FLUSHING WORKS FOR THE KINNICKINNIC RIVER are to be built by the city of Milwaukee, Wis. Mr. Geo. H. Benzenberg, M. Am. Soc. C. E., City Engineer of Milwaukee, informs us that $125,000 has been appropriated to begin construction. The flushing tunnel will be about 1½ miles in length. It is expected that a contract for part of the work will be let this fall.

THE HOLTHAUS SYSTEM OF GARBAGE disposal has been adopted at Milwaukee, Wis. A contract with Crilley & O'Donnell has been authorized by the city council providing for the collection and disposition of the garbage for a period of five years for the lump sum of $274,500. Mr. G. H. Benzenberg, M. Am. Soc. C. E., is City Engineer, and was a member of the committee that recommended the Holthaus system. We are indebted to Mr. Benzenberg for the above information.

THE COMMERCE OF LIVERPOOL is thus reported upon by the Mersey Docks and Harbor Board for the year ending June 30, 1897: Number of ships paying dock tonnage rates was—foreign, 518 sailing vessels of 438,208 tons, and 3,821 steamers of 6,303,829 tons. Coastwise vessels paying dock dues were: 1,727 sailing vessels of 147,907 tons, and 9,148 steamers of 2,007,661 tons aggregate. Including vessels paying harbor rates only the grand total for the year was 23,640 vessels of an aggregate tonnage of 11,473,421 tons; as compared with 23,695 vessels of 11,046,457 tons in 1896.

EXPORTS FROM THE UNITED STATES, says the Treasury Bureau of Statistics, for the fiscal year ending June 30, exceeded by $21,700,000 the total of 1892, the previous largest total in the history of the country. For June last the exports were valued at $74,174,689, an increase of $7,400,000 over June, 1896. The imports for the same month represented $84,826,110, an increase of $28,600,000 over the corresponding month of last year. For the twelve months ending June 30, the value of the total exports was $1,051,987,091, an increase of $169,000,000 over the year 1896. The imports for the last year were valued at $764,373,905, a decrease of over $15,300,000 from the preceding year, with dutiable and non-dutiable imports about balancing each other in value. The exports for the last fiscal year exceeded the imports by $287,613,186 in value, or about double the excess for the previous year.

THE COMMERCE OF ENGLAND and its colonies, between 1837 and 1897, covering the Victorian reign, has grown from less than 3,000,000 tons of shipping to nearly 15,000,000 tons. The combined imports and exports of the British Empire grew in the same period from $487,000,000 to $3,650,000,000. This is according to a statement recently made by the Earl of Hopeton, the First Lord of the Admiralty, as President of the Institution of Naval Architects.

THE CHICAGO WATER SUPPLY system is to have additional pumping plant, and the 68th St. intake tunnel is to be completed. The city council has unanimously approved the reports of the Finance Committee appropriating $190,000 for two pumps, one of 30,000,000 gallons capacity at 14th St., and the other of 12,000,000 gallons capacity at 68th St., and $30,000 for the completion of the 68th St. tunnel. In order to meet these expenses the council has passed an ordinance for the issue of water tax certificates for $1,000,000, payable in December, 1898, and June, 1899.

THE RECENT HOBOKEN WATER CONTRACT, noted with editorial comment in our issue of May 6, may be reviewed by the courts, an order having been issued for the city to show cause why a writ of certiorari should not be issued for reviewing the matter. The city called for bids for a new supply and then suddenly, only four days before the date set for receiving bids, renewed its contract to the Hackensack Water Co., which has been supplying water to the distribution system of the city for a number of years. The application for the writ states, among other things, that Messrs. Rogers & Farrell had gone to considerable expense preparatory to submitting a bid, and were prevented from doing so by the sudden award of the contract.

THE VARIOUS WATER SUPPLY PLANS before the city council of Philadelphia, now 13 in number, have been referred to Mr. Thos. M. Thompson, Director of Public Works, for consideration and report. It is stated that he will make an extended tour of inspection of filtration plants in this country.

TWO STORAGE RESERVOIRS IN THE ARIZONA desert are reported as having been contracted for by the Atchison, Topeka & Santa Fe Railway Co. to supply its locomotives with water. It is stated that the reservoirs will be formed by masonry dams about 40 ft. in height, impounding 50,000,000 gallons of water each and costing about $200,000, the interest charges on which will be much less than the present cost of hauling water. Mr. Jas. Dun, M. Am. Soc. C. E., of Topeka, Kan., is Chief Engineer of the above railway company

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred July 19 on the Rio Grande Western Ry. west of Green River, Utah. An east-bound express ran into a sand drift and the engine turned over, killing the General Roadmaster, who was on the engine at the time, and fatally scalding the engineer.

A FREIGHT TRAIN JUMPED THE TRACK July 17 at Keene, N. H., while running on the Fitchburg Ry. The engineer is reported killed and two others seriously injured.——On July 14 an engine jumped a switch at the Harrisburg, Pa., station of the Pennsylvania Ry. and turned over, crushing the engineer's son, who was on the engine. The fireman broke a leg in jumping.

AN EXPLOSION OF GUNPOWDER at the factory of the Winchester Repeating Arms Co., of New Haven, Conn., occurred July 21, and resulted in the death of seven persons, and the injury of several more. The explosion took place in the "loading room" where paper shells for shot gun cartridges are loaded by machine, and the only explanation which can be had of its cause is that there was more than the required amount of powder in one of the machines.

THE RAISING OF A LOCOMOTIVE from the Chicago River, near Kinzie St., Chicago, has been accomplished by the Chicago Dredging & Dry Dock Co. On June 17 the engine and tender of a suburban train on the Chicago, Milwaukee & St. Paul Ry. fell into the river at the open drawbridge, the engine lying in about 18 ft. of water. After lifting out the tender and the engine truck by means of a derrick, a diver was sent down and found that the engine lay almost on its side, with the front end sunk about 4 ft. in the mud. The diver passed a line under the forward end of the boiler and thus a heavy chain was passed under, while another chain was fastened inside the firebox door. The chains were attached to two scows, partly filled with water, and on the water being pumped out, the locomotive was raised sufficiently to enable it to be moved across the river and there let go at a point where there was more room for getting it ashore. The two scows were then placed on either side of the submerged engine, and chains attached to the four driving wheels and the smokebox were carried up to six heavy timber levers carried on 14 ft. of blocking on the scows. These were operated by jack screws, toggles gripping the chains, while the levers were lowered for another lift. When the engine was raised between the scows they were swung round to drop it on a temporary track laid down the bank. The work was done by 14 men, and owing to the small space available about 7 days were required to do it.

BAD TRACK CONSTRUCTION ON AN ENGLISH railway has been brought to light by the derailment of a passenger train at Welshampton on the Cambrian Railway, June 15, in which 11 persons were killed and 25 were more or less injured. The government inspector stated that the track reminded him of an "old rag and bone shop." The track was of the English type, having double-headed rails, secured in cast-iron chairs by the wooden "keys" or wedges which are,as we have before pointed out, a very weak point in this type of construction. It is suggested that the warm dry weather following two days of rain may have caused the keys to shrink so that some of them fell out, as not unfrequently happens, while the consequent loosening of the rail might cause others to be shaken out so that the pressure of the wheels might force the rail outwards in the chairs so far as to allow the wheels to drop down inside the rail. The accident occurred to an excursion train of 15 cars drawn by two engines. Neither of the engines left the track, but the tender of the second engine and several cars were derailed and upset and the cars badly smashed.

THE IMPERIAL RAILWAY OF CHINA, says Consul Read, Tientsin, opened to traffic in April, 1897, 40 miles of railway beyond Shan-hai-Kwan, along the Liaotung Gulf and in the direction of Kin Chou. The total length of line, from Tientsin to Chung-hou-so, the terminus of the line above noted, is now nearly 214 miles. The line from Tientsin to Peking will be opened shortly, as only a few miles, near Peking, remain to be constructed. This will add 80 miles to the above total. Mr. C. W. de Kinder, M. Am. Soc. C. E., Chief Engineer of the Imperial Railways, reports the surveys completed for the Pekin-Poating-fu extension of 80 more miles.

THE THIRD-RAIL SYSTEM FOR ELECTRIC TRANSmission is being tested on the Manhattan Elevated Railway; but the statements made in some of the New York papers that an electric system had been adopted are positively denied by the officers of the company. They are not satisfied that the third-rail system is without danger to employes, and rather favor some form of compressed air motor.

THE ELECTRIC CAR SERVICE over the Brooklyn bridge is supposed to be facilitated by a plan devised by the engineers for four trolley loops on the New York side, all practically within the present bridge property. The plan has been approved by all the surface railway presidents, and it is now being elaborated. Generally speaking, the plan provides for a platform 16 ft. above the bridge cable-car tracks and 180 ft. long. This space would be crossed by four loops of the electric road, each loop capable of loading and unloading two cars at a time, or eight in all. To carry this platform the present bridge structure would have to be widened 16 ft. on each side. The loops would be approached by two tracks on each side, and interlocking switches would be unnecessary. As this platform would be about 50 ft. above the pavement, an elevator service is proposed, consisting of 16 elevators in pairs, each with a capacity of 40 persons, or a combined capacity of 16,000 persons per hour.

AMERICAN RAILS WIN IN CHINA, according to a paragraph given out by the State Department in Washington. In a late competition for railway material at Tien-Tsin, the prices quoted for Carnegie steel rails, by Mr. C. D. Jameson, an American civil engineer now resident in China, was the lowest, and two consignments, valued at $310,950, have been shipped. Mr. Jameson is a member of the Am. Soc. C. E., and was formerly Professor of Civil Engineering in the State University of Iowa.

IMMIGRATION RETURNS for the port of New York for the fiscal year ending June 30, 1897, show 180,556 immigrants arriving, of whom 106,040 were males, and 129,672 were between the ages of 15 and 40 years. The illiterate immigrants numbered 37,062; and the total amount of money brought by these immigrants was $671,262, an average of about $3.72 per head.

THE SEWAGE FILTER BEDS OF ALTOONA, PA.

The troubles of many inland cities over the disposal of their sewage are well illustrated by the experience of the City of Altoona, Pa., in connection with the discharge from an outfall sewer now serving nearly one-half of the population of the city. Like many other cities, Altoona is not located on a large stream or body of water capable of receiving all its sewage without treatment, and like many other communities, also, nuisances, damage and injunction suits have been the consequence of violating nature by discharging sewage into a stream that runs nearly dry in summer. Extensions of the particular outlet sewer in question at Altoona were made to avert nuisances and suits, but the city was finally brought up short by a court order prohibiting the use of a long extension down stream until means of purification were provided and proved effective. As a solution of the problem, intermittent filtration was finally adopted and the filter beds for this purpose are now under construction. A view of a portion of the beds is shown by Fig. 1, reproduced from a photograph taken by Mr. Geo. M. McKinney, Assistant City Engineer. The work is being done under the direction of Mr. Harvey Linton, M. Am. Soc. C. E., City Engineer of Altoona. Mr. Rudolph Hering, M. Am. Soc. C. E., and Mr. Allen Hazen, Assoc. M. Am. Soc. C. E., both of New York, have been called in by the city as consulting engineers, in connection with the disposal problem, as noted more fully below.

FIG. 1—VIEW OF SEWAGE FILTER BEDS AT ALTOONA, PA.
Harvey Linton, M. Am. Soc. C. E., City Engineer.

We are indebted to Mr. Linton for the information given in this article, a considerable part of which was presented by him during the first part of this year before the Engineers' Club of Philadelphia, and also before a conference held at Johnstown, Pa., under the auspices of the Pennsylvania State Board of Health.

The city of Altoona is located at the base of the Allegheny Mts., near the sources of the Juniata River. Its elevation above sea level ranges from 1,110 to 1,335 ft. The city has an area of 2.28 sq. miles. Its population increased from 19,710 in 1880 to 30,337 in 1890, and is largely engaged in industries pertaining to the shops of the Pennsylvania Railroad system, there being in addition some manufacturing and coal mining interests.

Water-works were built by the city in 1871. The supply is by gravity from impounding reservoirs. The outfall sewer for the first district was completed in 1874, since which three other districts, comprising the remainder of the city, have been established and wholly or partially provided with sewers. The sewers are on the combined plan, but the outfall of the fourth district is not capable of carrying all the surface water, even when the rainfall is not excessive. The outfalls of the other districts are sufficient to carry off a rainfall of 2 ins. per hour.

The larger part of the surface drainage of the city naturally goes into a small stream flowing northeastward. A little less than half the city, the portion for which the filter beds are being constructed, known as the fourth district, naturally drains into a stream flowing southward toward Hollidaysburg. These two streams unite at Petersburg, 27½ miles east of Altoona, and form the Juniata River. The fourth district sewer serves a total drainage area of 2½ miles, only 1.11 sq. miles of which is in the city limits, but the sewer is not large enough to carry all the surface drainage from this area, and so overflows are provided at two or more points. The disposal works are designed to serve at present a population of about 15,000 people in the fourth district, and some 3,000 in suburban territory which would naturally be served by this system, and may be enlarged so as to serve a population of 27,000. It is expected that the sewage from the other three districts, which, as has been said, discharges into another stream, will eventually have to be purified, but land suitable for filtering this sewage has not yet been found.

The fourth district outfall sewer will eventually discharge at a point three miles below the city, where the junction of Sugar Run with Mill Creek forms the Little Juniata River. The drainage area of the combined streams here is 40 sq. miles, which is 2.7 miles per 1,000 of population connected with the sewer, but only 1.5 miles per 1,000 of population for which sewage disposal is finally to be provided.

Located 3½ miles below the new outfall, as the water flows, is Hollidaysburg, which had a population of 2,975 by the census of 1890. The drainage area above the borough is 75 sq. miles. The stream has a fall of about 40 ft. per mile above the borough, but opposite it the fall is less rapid and a dam makes slack water for some distance.

The rainfall at Altoona, according to records kept by Dr. Chas. B. Dudley, Chemist of the Pennsylvania Railroad Co., was 21.17 ins. in 1895, and 33.44 in 1896. Records kept by the Altoona water department at Kittaning Point, about 300 ft. above the gage in the city, showed a rainfall of 31.58 ins. in 1895, and 41.03 ins. in 1896. Weir measurements of the dry weather flow of Sugar Run and Mill Run, at their junction at the lower end of the new outfall sewer gave a daily flow of 621,930 gallons in Sugar Run on Nov. 8, 1895, and of 728,957 gallons on Nov. 11, 1895, or a total of 1,350,887 gallons. This included the discharge from the outfall sewer. Gagings of the sewage flow made during seven days in October, 1895, showed a minimum of 380,000, and a maximum of 559,000 gallons a day, but the water supply was then cut off during 20 hours of the day, or except between 4 and 8 p. m., on account of the drouth. In general, it may be stated that the dry weather flow of the creek draining the fourth district is practically nothing down to where Mill Run comes in, and from this point to Sugar Run is too small to afford sufficient dilution of the sewage to prevent a nuisance.

Suits for pollution by sewage were first brought against the city in 1882. These were repeated in 1889, and were for the pollution of springs about 2⅛ miles below the city limits, and more than that distance below the end of the outfall sewer as then constructed. The allegation was that the springs were contaminated by the sewage-polluted water from Mill Creek reaching the springs through underground channels in the limestone. Mr. Linton states that this allegation was never very clearly established. Nevertheless the city paid $9,368 in damages and costs as a result of the suits.

In 1889, Mr. Hering, already mentioned, suggested such an extension of the outlet sewer as has been made recently, and in 1889 Mr. Linton made surveys for it. Nothing further was done until 1895, when Mr. Hering was again called, and again recommended the extension of the outlet sewer, stating that whatever the ultimate solution of the problem might be the sewage would have to be carried further down the valley in order to secure more dilution. In case purification proved necessary, he recommended intermittent filtration.

In November, 1895, construction was begun on an extension of the outlet sewer to the junction of Sugar Run with Mill Run, it being assumed that the increased volume of water at this point would sufficiently dilute the sewage to avert all complaints. The borough of Hollidaysburg thought otherwise, and joining with them the adjoining borough of Gaysport, the burgesses of the two boroughs, the board of health of Hollidaysburg and a number of private citizens applied for an injunction to prevent the construction of the sewer extension and from discharging sewage into the stream flowing between the two boroughs. The evil results feared from the sewage were set forth in the complainants' bill as follows:

> This sewage will pollute the waters of the stream from Sugar Run to a great distance southwest of the Borough of Hollidaysburg; at certain seasons of the year and in times of drouth there is little or no water to pass over the bed of the same, or parts of the same, and the undiluted sewage will be exposed and will produce offensive and deleterious gases. In time of rain, when the water is raised, the sewage will be washed down the stream and will mingle with and contaminate the entire body of water within the limits of the boroughs, and for great distances on either side. And thus the emptying of the sewage in the manner indicated, into the waters of the said stream, will work a nuisance to the public and to all citizens resident upon, or in the vicinity thereof, and will poison the air, pollute the waters and render them unfit for any useful purpose, and will offend the private and public comfort, will be injurious to health, will produce disease, and destroy the territory thus affected for purposes of residence or business. And this annoyance and evil will increase with the growth of the city, and will inflict upon complainants irreparable injury.

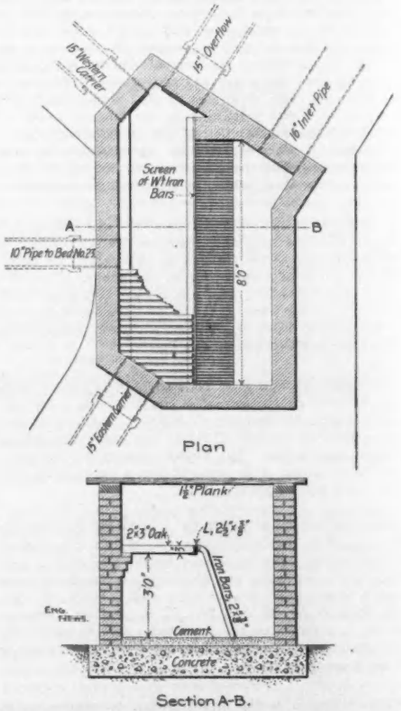


Fig. 2.—Plan and Section of Sewage Screening Tank at Altoona, Pa.

The court soon issued an injunction forbidding the use of the sewer until after the completion and successful operation of the filter beds now being built.

The outlet sewer extension was completed in August, 1896, at a cost of $42,912. For the first 6,665 ft. from the city limits it is of 27-in. vitrified sewer pipe. For the next 3,183 ft. it is of 30-in. pipe. For the last 5,773 ft. it is a 33 × 44-in. concrete and brick sewer, the invert being of vitrified paving brick. On the line of the extension there are 36 manholes, of which 34 have perforated covers. The manholes in the 30-in. portion of the sewer passing through Llyswen are built near the center of the street intersections in order to admit sewage from this village, if desired.

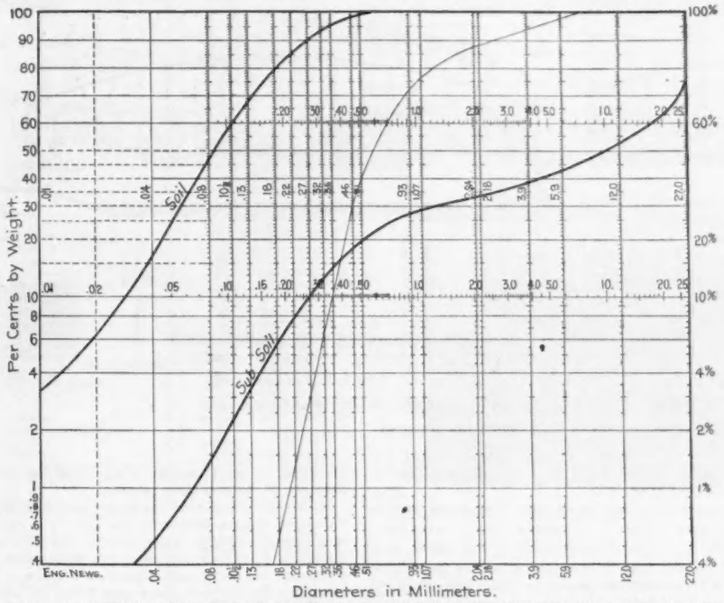


FIG. 3.—DIAGRAM SHOWING RESULTS OF MECHANICAL ANALYSIS OF SOIL AND SUBSOIL AT SITE OF SEWAGE FILTER BEDS AT ALTOONA, PA.
Allen Hazen, Assoc. M. Am. Soc. C. E., Consulting Engineer.

In dry weather all the sewage from the fourth district will go to the filter beds. In wet weather the combined sewage and storm water in excess of about 17,000,000 gallons will overflow into Mill Creek at the present outlet, at the upper end of the extension, but there will be no overflow here until the matter brought by the sewer is well diluted by surface drainage and has some stream flow in addition to receive it. At the lower end of the sewer extenson there is an overflow weir to Sugar Run, where, as stated above, 40 sq. miles of drainage area will be contributing to the stream and the amount of sewage will be small in comparison with the rain-swollen volume of the stream. The lower end of the old outlet sewer, at the city line, has a cross-section of 4½ × 6¾ ft.

From the end of the new extension at Sugar Run the sewage to be treated will be diverted to the filter beds through 1,440 ft. of 18-in. vitrified pipe sewer, and 200 ft. of 16-in. cast-iron inverted siphon. The sewage will be received in the screening tank, shown in detail by Fig. 2. The wooden grating is designed as a platform for the rakings from the screen to dry upon before final disposition. The flow from the screen chamber will be controlled by circular gates consisting of a plate revolving round a pin at one side, similar to those in use at Framingham, Mass., and at Plainfield, N. J., the latter having been described and illustrated in Engineering News of Sept. 10, 1896.

The disposal area bought by the city includes 96 acres of land, of which about 70 acres can be graded for filter beds, which is now being done. The remaining 26 acres is taken up with the highway, river and wooded areas on hillsides. The land cost the city $12,000. Before deciding on this site, Mr. Hazen, who has been mentioned above, was called in to examine the land and test the soil. A number of test pits were dug to the ground water level, here 6 to 9 ft. below the surfece of the ground, and samples were taken for analysis. In a report made in August, 1895, Mr. Hazen described the material at the site of the beds as follows:

> The material of this land is made up of two distinct layers; the upper layer is from 1 to 5 ft. in depth in different parts of the field, and consists of fine, sandy soil or loam, with fine sand below. The upper part of the soil differs from the lower part of the layer only in containing more organic matter and the difference is not great enough to warrant any subdivision of the materials in handling it. The material allows water to percolate through it somewhat freely, but it contains a considerable amount of iron and alumina, as is shown in the chemical analysis, and these and other gelatinous materials allow it to be compacted more closely than fine sand, and to cake together into a solid mass upon drying, after having been wet. The second kind of material underlies the upper layer and is much more open in its texture, and consists of particles ranging all the way from moderately fine sand to boulders a foot in diameter.

A diagram showing the results of a mechanical analysis of the filtering material is shown by Fig. 3.

The disposal area, or that portion laid out in beds, is a long, narrow strip of land, located between the Hollidaysburg branch of the Pennsylvania Railroad and a public highway. The Little Juniata River, into which the effluent is discharged, flows along the upper end of it, then parallels the railroad, with a bend half-way into the area about midway in the length of the field. Forty beds are laid out, mostly in long, narrow form, at right angles to the greatest length of the area. The underdrains run in the opposite direction.

The underdrains have an aggregate length of nearly six miles. They consist of 3 to 6-in. agricultural tile, and 8 to 15-in. sewer pipe. They are laid from 4 to 6 ft. below the surface of the beds and discharge at the surface of the stream, through cast-iron pipe.

The grading of the beds involves the handling of about 58,000 cu. yds. of material. The cuts on each bed are sufficient to bring it to grade and to make the surrounding embankments.

The sewage is conveyed from the screening tank to the beds through 10 to 15-in. sewer pipes laid in the outer embankments, each bed having a 10-in. supply pipe. Intermittent filtration will be employed. The quantity and frequency of the doses of sewage are yet to be determined by practice.

The contractor for the beds is Mr. Wm. H. Herr, of Altoona. Construction was started on Aug. 26, 1896, and most of the beds will be ready for use in August, 1897.

The estimated cost of the filter beds, including engineering, is from $15,000 to $17,000, including 1,600 ft. of 18-in. sewer from the present outfall to the beds, and 200 ft. of 16-in. cast-iron pipe for an inverted siphon. The land cost $12,000. The attorney fees and cost of expert testimony at the court at Hollidaysburg, Pa., Jan. 3, 1896, was $1,505. The extension of the outfall sewer, begun before the filter beds were decided on, cost $42,912, as has already been stated. The total loan authorized for sewage disposal purposes, including this outfall sewer, was $98,000, bearing 4% interest.

A NEW TRUSS DESIGN AND ITS ANALYSIS.

By C. L. Strobel, M. Am. Soc. C. E.

A variety of special designs for bridges submitted in competition for prizes have recently been published. Such designs, if carefully worked out so as to show the proportioning of parts and the weights and cost, often furnish information to the engineer valuable in his future work. The writer thought it would interest some of your readers to send you for publication one of the designs, including strain sheet, so worked out, prepared by him in connection with the competition for the Sixth St. bridge, Pittsburg, Pa., in 1890 and 1891. The type of truss adopted is unusual, and, at least,

Fig. 1.—Lohse Truss Used in Elbe River Bridge at Hamburg, Germany.

the strains and sections resulting from this form of truss would seem to possess general interest. The conditions which led to the adoption of a design of this kind may be briefly stated as follows:

The company owning the old bridge, which was a Roebling suspension bridge of a very pleasing appearance, wished to replace this structure with a new bridge, which, besides affording the stiffness and strength requisite for the very heavy traffic which it must accommodate, should also present a pleasing, and, if possible, a unique architectural appearance. The bridge is a toll bridge, and the company had abundant means and the willingness to pay for a structure which should satisfy these conditions. The company invited designs from engineers on two separate occasions, each time offering a prize for the best design. No award under either of these competitions was made, and no compensation was ever paid to any of the engineers participating in them. The excuses which were made by the company for pursuing this course need not be reviewed here. The company decided eventually to place the construction of the new bridge in charge of an engineer, and bids were asked from contractors under general specifications in the usual way.

The writer took part in both competitions for prizes and also in the competition for the contract, the latter in his capacity as Chief Engineer, at that time, of the Keystone Bridge Co. The design illustrated represents one of the designs on the

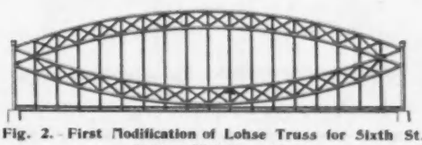


Fig. 2.—First Modification of Lohse Truss for Sixth St. Bridge, Pittsburg, Pa.

basis of which a tender for the construction was submitted by him on behalf of the Keystone Bridge Co. Another design and proposal were submitted by him at the same time for an ordinary truss, with parabolic top chord, very similar to the bridge as built, and representing the most economical structure possible.

The genesis of the truss selected for the special design was as follows: A strong preference had been expressed by members of the company for a bridge of the type of the structure across the Elbe, at Hamburg, Germany, on account of its pleasing architectural effect. This type, which is known by the name of its inventor as "System Lohse," is indicated by the sketch, Fig. 1. The upper half of the truss is an arch similar to the Ends bridge at St. Louis. This is combined with an inverted arch of the same form, each arch having its own chords and web bracing. The two arches are connected

by vertical members only, and resistance is one-half by each system. This type of construction is costly. Four chords are used where two ordinarily serve the purpose, and riveted chords are employed in tension where eye-bars ordinarily perform the duty required of them better and more cheaply. It was also considered objectionable to use two systems of web bracing when one system would answer the purpose. The fact that the strains in this truss are statically indeterminate was another disadvantage.

The writer thought it desirable to adopt such a type of truss as would furnish a pleasing and effective portal, and to obtain this he considered it essential that the component parts of it be in a vertical plane. The portal is the only part of the structure that can be seen to advantage by the beholder in approaching the structure, and the writer thought he would be justified in incurring some expense to produce a good architectural effect in this connection. Furthermore, it was an open question whether the abutments should not be treated as towers, built of masonry, since ticket and other offices were needed at the ends of the bridge, and these could be conveniently provided in these towers. The writer reasoned that the additional expense to produce a pleasing architectural effect should be limited to the additional cost of providing vertical portals or masonry towers,

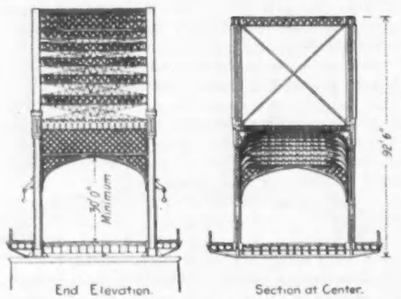


Fig. 4.—Elevation and Cross Section Showing Appearance of Sixth St. Bridge When Viewed from the End.

and that otherwise this result must come exclusively from the constructional lines of the truss without additonal expense or other disadvantage, as, for instance, by making them conform to curves which in themselves would be pleasing to the eye.

Fig. 2, showing a truss, the upper half of which is a braced arch, and the lower half of which is a catenary formed of eye-bars, represents the first step in the evolution of the truss as finally adopted. This truss would be cheaper to build than the Lohse truss, but the calculation of strains would still be statically indeterminate, and while there would be only one system of web bracing, there would still be three lines of chords. The truss finally adopted is shown in Fig. 3. The upper chord is a single compression member of nearly uniform section. The resistance to partial loading comes entirely from the double lower chords and the web bracing between them. It will be seen that these two chords are virtually halves of one chord. These halves are separated from each other a sufficient distance, so that, by using web bracing between them, the required stiffness and resistance to partial loading is obtained. At the same time the curves are such that the strains in the two chords remain tensile for every condition of loading. As these chords are made of eye-bars, the grouping of them in two curved lines does not involve extra expense of any moment.

The strain sheet will show that the sizes of the parts for this design are exceedingly convenient, permitting of very simple details for the joints, and that shop manufacture is as cheap as for an ordinary truss of similar proportions. The upper chord is an arc of a circle, to which are connected only light vertical members, of uniform size, and strained in tension only. For convenience in erection and to furnish additional stiffness, these vertical members are laced, and made capable of taking compressive strains. As the two lower chords are of eye-bars, it is only necessary to make these and the posts between them of correct length to obtain the curves, so that here again the shop manufacture is convenient and inexpensive. The diagonal bars between the two tension chords are made adjustable, and, as this web bracing is light, it is easily managed.

The advantages of this type of truss over the trusses indicated by Figs. 1 and 2 are its lower cost and the fact that all the strains are statically determinate. The strains can, therefore, be calculated with the precision that obtains for the ordinary Pratt truss. It will be seen that the deflection of this truss is kept within the usual moderate limits, and that no members are in such position that they would be easily subjected to vibration. The absence of lower chords in the plane of the floor is not in this case a disadvantage with respect to wind bracing, as buckled plates were to be used for the floor, and these in themselves would furnish all the resistance to wind needed.

The architectural effect, it was thought, would be pleasing. The heavy members are practically uniform in dimensions, which is a desirable feature from the standpoint of a good appearance. The lower chords are parabolic curves, and the upper chord an arc of a circle. These curves are in themselves pleasing. Their effect is not disturbed by the web bracing, as this is light and simple. The bridge has that openness which is desirable for highway traffic.

On the basis of estimates in detail which were prepared in competing for the contract, the cost of the bridge built on this design, and the cost of the bridge built on the alternative design above mentioned, representing the most economical truss which could be selected, were carefully determined, it was found that the bridge on the former design cost more than the bridge on the latter design by an amount which represents the cost of the material in the end posts alone. The difference is comparatively a small one, amply warranted, it was thought, by the desirability of providing an attractive portal for a bridge of its magnitude and importance. The other special features of this truss did not entail additional expense or other disadvantages.

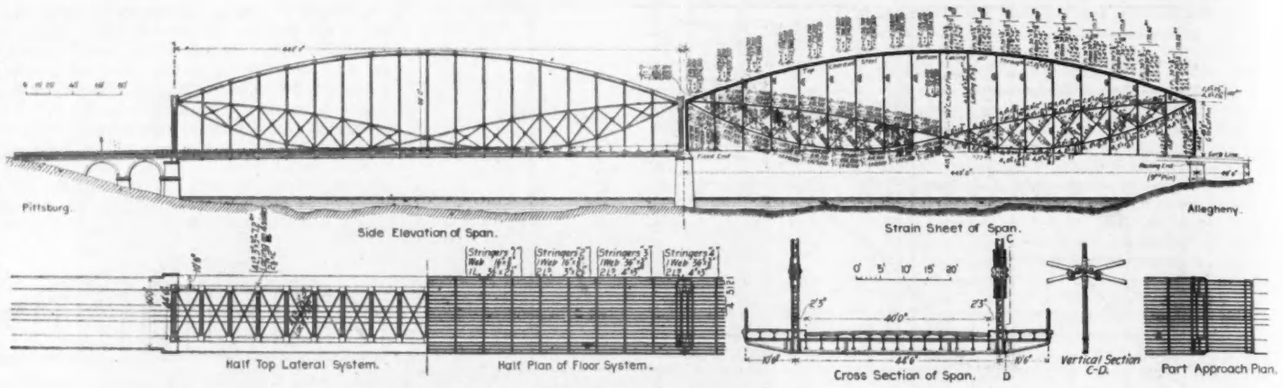


FIG 3.—FINAL DESIGN AND STRAIN SHEET FOR SIXTH ST. BRIDGE AT PITTSBURG, PA.
C. L. Strobel, M. Am. Soc. C. E., Chicago, Ill., Designer.

COST OF ELECTRIC MOTIVE POWER FOR STREET CARS IN NEW YORK AND MASSACHUSETTS.

The figures in the accompanying table are taken from the last annual reports of the Boards of Railroad Commissioners in New York and Massachusetts for all or nearly all the street railway properties in those two states which operate power stations. The returns are arranged in the order of car mileage run for the year, as the magnitude of operation has theoretically an important influence on the cost of electromotive power.

Of the 19 companies operating less than 250,000 car miles per annum four only are obtaining motive power at a cost of less than 2 cts. per car mile; six at between 2 cts. and 3 cts. per car mile; five at between 3 cts. and 4 cts. per car mile; one at between 4 cts. and 5 cts. per car mile; and three at more than 5 cts. per car mile.

Of the 21 companies operating between 250,000 and 500,000 car miles per annum, nine are obtaining motive power at a cost of less than 2 cts. per car mile; five at between 2 cts. and 3 cts. per car mile; three at between 3 cts. and 4 cts. per car mile, and four at between 4 cts. and 5 cts. per car mile.

Of the 10 companies operating between 500,000 and 1,000,000 car miles per annum, five are obtaining motive power at a cost of less than 2 cts. per car mile; four at between 2 cts. and 3 cts. per car mile, and one at between 3 cts. and 4 cts. per mile.

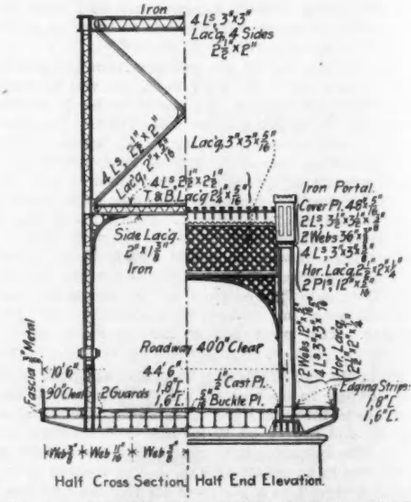


Fig. 5.—Sectional Elevation of Sixth St. Bridge Showing Composition of Portal Bracing and Floor System.

Of the 15 companies operating between 1,000,000 and 5,000,000 car miles per annum, ten are obtaining motive power at a cost of less than 2 cts. per car mile; four at between 2 cts. and 3 cts. per car mile; and one at between 4 cts. and 5 cts. per car mile.

Of the five companies operating over 5,000,000 car miles per annum, one is obtaining motive power at a cost of less than 1 ct. per car mile; three at between 1 ct. and 2 cts. per car mile, and one at between 2 cts. and 3 cts. per car mile.

The Brooklyn Heights Railroad Company has the cheapest power of any steam plant in the list, $.0086 per car mile; the Binghamton Railroad Company follows with $00.94, and among the others whose costs of motive power

are especially low may be mentioned the Wakefield & Stoneham Street Ry. Co., $.0143; the Auburn City Ry. Co., $.0104; the Middletown & Goshen Traction Co., $.0142; the Poughkeepsie City & Wappingers Falls Electric Ry. Co., $.0129; the Lynn Street Ry. Co., $.0140; the Lowell

Name of Company.	Cars owned.	Car mileage for year.	Cost of Electric Motive Power. Per car mile.	Per pas. seng'r.
Schenectady	14	70,000	.1138	.0121
Dunkirk & Fredonia	9	72,142	.0666	.0215
Gardner	6	79,058	.0323	.0112
Hoosick	8	92,231	.0198	.0050
Hornellsville & Canisteo	6	94,680	.0185	.0055
Olean	11	117,530	.0265	.0076
Leominster & Clinton	14	122,306	.0354	.0092
Pittsfield	15	130,106	.0378	.0066
Reading & Lowell	7	142,797	.0357	.0147
Greenfield & Turners Falls	13	160,078	.0219	.0050
Athol & Orange	10	163,797	.0133	.0067
Hornellsville	9	177,025	.0171	.0114
Plymouth & Kingston	12	177,876	.0299	.0081
Kingston City	11	187,650	.0409	.0074
Natick & Cochituate	15	189,767	.0322	.0081
Utica & Mohawk	8	204,306	.0255	.0093
Citizens (Fishkill)	25	213,190	.0242	.0066
Marlborough	14	220,151	.0198	.0060
South Middlesex	16	249,277	.0290	.0071
Gloucester	24	257,613	.0459	.0092
Hoosac Valley (North Adams)	29	279,480	.0292	.0061
Gloucester, Essex & Beverly	23	304,085	.0309	.0084
Ithaca	22	309,701	.0182	.0036
Watertown & Brownville	24	326,500	.0090	.0029
Braintree & Weymouth	20	339,374	.0374	.0135
Rockland & Abington	26	335,441	.0413	.0097
Wakefield & Stoneham	20	335,780	.0143	.0037
Taunton	52	340,523	.0270	.0058
Newton	32	341,244	.0224	.0044
Auburn City	28	381,985	.0104	.0041
Norfolk Suburban	28	382,962	.0416	.0077
Quincy & Boston	42	397,014	.0170	.0032
Buffalo, Bellevue & Lancaster	23	397,625	.0202	.0017
Haverhill & Amesbury	36	401,160	.0413	.0114
Newburgh	33	405,971	.0231	.0057
Middletown-Goshen	21	414,210	.0142	.0048
Geneva, Waterloo, Seneca Falls & Cayuga Lake	30	417,000		.0069
West Side (Elmira)	14	426,928	.0160	.0053
Niagara Falls & Suspension Bridge	29	444,652	.0177	.0054
Yonkers	29	445,190	.0374	.0093
Northampton	30	496,648	.0163	.0044
Elmira & Horseheads	48	505,890	.0169	.0062
Poughkeepsie City & Wappingers Falls	20	550,108	.0129	.0038
Worcester & Suburban	48	619,408	.0315	.0063
Jamestown	50	627,784	.0231	.0059
Fitchburg & Leominster	37	631,137	.0210	.0062
Interstate Consolidated	55	652,577	.0281	.0078
Union (New Bedford)	88	747,915	.0207	.0030
Holyoke	69	803,712	.0179	.0042
Utica Belt	70	827,095	.0153	.0036
Binghamton	73	839,500	.0094	.0023
Globe (Fall River)	100	1,143,051	.0197	.0039
Syracuse Consolidated	113	1,266,923	.0204	.0091
Brockton	112	1,291,633	.0240	.0050
Lowell, Lawrence & Haverhill	143	1,443,730	.0243	.0043
Syracuse Street	106	1,687,463	.0140	.0040
Lowell & Suburban	144	1,802,093	.0146	.0034
Steinway	226	1,885,638	.0147	.0042
Worcester Consolidated	139	1,929,992	.0426	.0054
Coney Island & Brooklyn	164	2,062,044	.0182	.0057
Troy	206	2,223,585	.0113	.0025
Albany	113	2,229,977	.0131	.0035
Brooklyn City & Newtown	272	2,332,536	.0188	.0033
Springfield	175	2,358,622	.0188	.0044
Union (N. Y.)	135	2,486,963	.0197	.0050
Brooklyn, Queens County & Suburban	309	3,389,491	.0220	.0048
Rochester	227	5,010,862	.0144	.0042
Lynn & Boston	519	5,379,216	.0188	.0038
Buffalo	255	6,262,500	.0078	.0012
Brooklyn Heights	1811	21,500,745	.0086	.0017
West End	2422	25,841,907	.0277	.0043

& Suburban Street Ry. Co., $.0146; the Steinway Ry. Co., $.0147; the Troy City Ry. Co., $.0113; and the Rochester Ry. Co., $.0144.

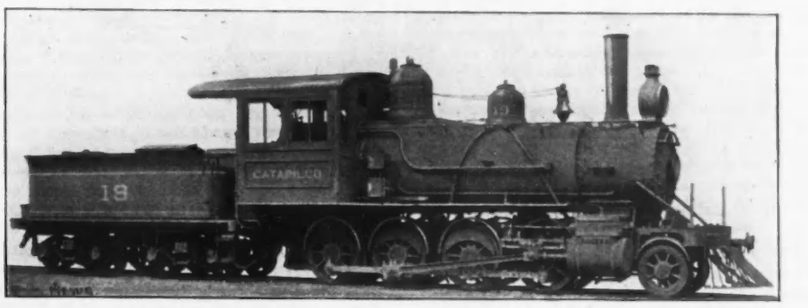
It should be noted that the reports of cost of electromotive power for all the Massachusetts roads include repairs and depreciation of station plant, which is not the case with the New York roads.—"Street Railway Journal."

CONSOLIDATION LOCOMOTIVE FOR THE CHILEAN GOVERNMENT RAILWAYS.

A number of meter gage locomotives for the Government railways of Chile, South America, have been built by the Rogers Locomotive Co., of Paterson, N. J., and we illustrate herewith one of the consolidation freight engines. The engine is of the ordinary American type, and has a wagon-top boiler with short extension smoke-box, but the firebox (for bituminous coal) is of copper. Laird guides are used and the connecting rod is of I. section while the side rods are of rectangular section. The pilot is formed of iron rods, with a plate set on edge for the nose. The tender is carried on two four-wheel trucks with diamond frames. We are indebted to the builders for a photograph and list of dimensions, which later we give below in our standard form.

Consolidation Freight Locomotive (Meter Gage); Chilean Government Railways.

Running Gear:	
Driving wheels, diameter	3 ft. 3 ins.
Truck wheels, diameter	2 " 6 "
Tender wheels, diameter	2 " 2 "
Journals, driving axles—main	6½ × 7½ "
" " " coupled	6 × 7½ "
" truck axles	4⅜ × 8 "
" tender axles	3¾ × 7 "
Wheel Base:	
Driving	12 ft. 2 "
Total engine	18 " 1 "
Wheels having blind tires	Second pair.
Weight in Working Order:	
On driving wheels	68,000 lbs.
On truck wheels	6,000 "
Engine, total	74,000 "
Cylinders	16 × 18 ins.
Distance, center to center	5 ft. 4 "
" center to valve face	4 " 10 "
Piston rod, diameter	3 "
Form of crosshead and guides	Laird.
Connecting rod, length between centers	7 ft. 10 "
Valve Gear.—Type	Shifting link.
Ports, steam	1¼ × 14½ ins.
Ports, exhaust	2½ × 14½ "
Slide valves, lap (outside)	11-16-in.
" " lead	1-16-in.
" " maximum travel	4½ ins.
Boiler.—Type	Wagon top.
Diameter of barrel inside	3 ft. 9 ins.
Thickness of barrel plates	½-in.
Thickness of smokebox tube plate	⅞-in.
Height from rail to center line	6 ft. 1 in.
Length of smokebox (to tube sheet)	4 ft. 3 ins.
Firebox.—Type	Plain, on top of frames.
Length inside	5 ft. 6 ins.
Width inside	2 " 3½ "
Depth at front	4 " 4¼ "
Depth at back	3 " 9¼ "
Thickness of side plates, copper	½-in.
" back plate "	½-in.
" crown sheet "	½-in.
" tube sheet "	½-in. and ⅞-in.
Grate area	12.60 sq. ft.
Staybolts, diameter, 1-in.; pitch	4 ins.
Water space, width, front	3½ "
" " " back	3½ ins.; sides 2¾ "
Tubes.—(Brass) number	146
Diameter, outside	2 ins.
Thickness, gage	No. 10 and No. 12 W. G.
Length, out to out	11 ft. 3 ins.
Heating Surface:	
Tubes, exterior	860.08 sq. ft.
Firebox	75.14 "
Total	935.22 "
Miscellaneous:	
Exhaust nozzle, diameter	Single; 3, 3¼, 3½ ins.
Smokestack, smallest diameter	12 "
Capacity of tank	1,500 gallons
Brake fittings	Westinghouse on tender and train
Tractive force per lb. effective pressure on piston	118 lbs.



CONSOLIDATION FREIGHT LOCOMOTIVE; CHILEAN GOVERNMENT RAILWAYS (METER GAGE).
Rogers Locomotive Co., Builders.

ELECTRIC ROTARY DRILLS ON TUNNEL WORK IN FRANCE.

The coal-mining company of Bouche-du-Rhone, France, has lately introduced into its works rock drills operated by electric power generated by utilizing the water under pressure which is contained in the strata through which the heading is being driven. The plant is described in "Le Genie Civil," and from this description the following abstract is made:—

The gallery, or heading driven is intended for draining the mines and for providing an economical outlet for lignite for the Marseilles market. When completed the heading will be about 8.7 miles long, with a cross section of about 54 sq. ft., and a grade of 1 in 1,000. The material penetrated is hard and compact limestone, but at many points water is met with under considerable pressure; the total flow being about 132 U. S. gallons per second. The hardness of the rock compelled the company to replace the hand-drills by some system of machine drilling, and the success of the electric drills used in constructing the general outlet for the sewerage system of Marseilles induced Mr. H. Dubs, the engineer in charge, to adopt them in this tunnel.

The presence of an abundant supply of water under pressure suggested the utilization of this power for operating the dynamo. The pressure available corresponded to a fall of 262 ft., or about 113 lbs. per sq. inch. The point selected for the installation of the motor plant was about 1.86 miles from the entrance of the tunnel, where the flow of water was about 19 gallons per second. A plant of 50 H. P. was deemed sufficient for running nine drills mounted on three carriages, with some surplus for other use.

On account of the high pressure, a Pelton wheel was adopted, and this was built by Escher, Wyss & Co., of Zurich, as shown in Fig. 1. The regulation is such that the variations of speed under varying loads does not exceed 5 per cent., except in the case of a sudden entire removal of the load, when it momentarily touched 10 per cent. This regulator was operated as follows: The water under pressure entered by the pipe A, and the valve placed at the outlet of this pipe at the turbine directed the water into the chamber B, when this valve was closed. This valve regulates the quantity of water striking the turbine buckets, and it is connected with the piston P in the cylinder B. This piston carries upon its upper face a threaded rod which passes through a stuffing-box and carries a small threaded wheel which controls a lever connected by another rod P to the arm T of the regulator M; and this arm T also controls the rod of the balancing chamber S. The movement of the arm T is retarded by the dash-pot Q, acting upon oil, and with a plunger

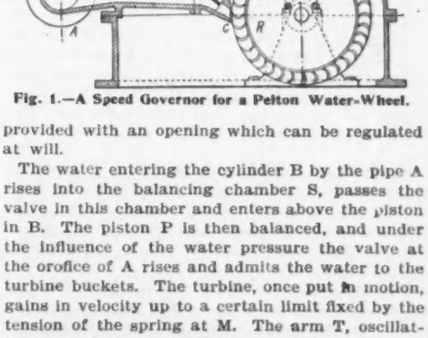


Fig. 1.—A Speed Governor for a Pelton Water-Wheel.

provided with an opening which can be regulated at will.

The water entering the cylinder B by the pipe A rises into the balancing chamber S, passes the valve in this chamber and enters above the piston in B. The piston P is then balanced, and under the influence of the water pressure the valve at the orofice of A rises and admits the water to the turbine buckets. The turbine, once put in motion, gains in velocity up to a certain limit fixed by the tension of the spring at M. The arm T, oscillating around the point Z, is operated by the cap on the regulator; and when the speed exceeds the limit fixed, it pulls up the rod of the lower valve in S, and shuts off the admission of water by the pipe N into the upper part of B; at the same time the movement opening an upper valve in the chamber S, establishes communication with the exterior by the escape pipe F. The equilibrium of the piston P being broken, it is raised under the influence of the pressure from below, and by lifting up the valve-rod closes down the jet valve and decreases the amount of water admitted to the turbine. The velocity of the turbine is thus decreased until the piston P is again balanced by equal water pressure and the operation is repeated. The tur-

bine has a speed of 600 revolutions per minute, or the same as the dynamo to which it is directly connected by an elastic friction clutch.

The dynamo was of the three-phase current type, made at the Oerlikon Works. The insulators carrying the conducting wires were fixed into a beam of paraffined wood fastened to the roof of the heading, and placed about 6.7 ft. above the ground; the wires have a diameter of 0.315 in., and they were supported at intervals of 26 ft. The conducting system was stopped at a point

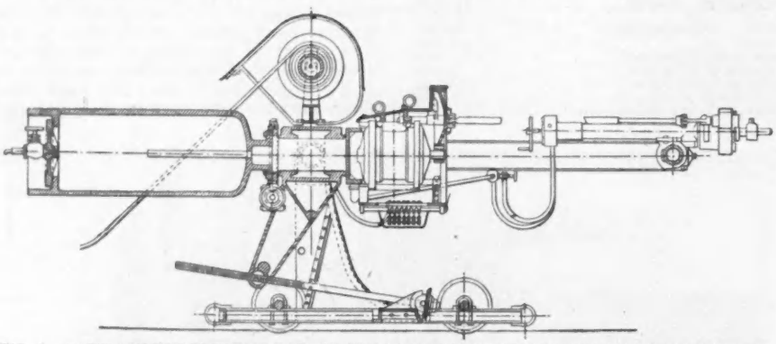


FIG. 2.—CARRIAGE FOR ELECTRIC ROTARY DRILLS IN TUNNEL OF BOUCHES-DU-RHONE COAL CO.

from 300 to 600 ft. back of the working face; and from that point to the drills it was conveyed by an elastic cable containing three wires. This cable was rolled up on a drum, when the carriage was withdrawn for firing.

The electric motors were carried upon the drill carriages, shown in Fig. 2, mounted upon a railway of the Decauville type, 1.72 ft. gage. On this carriage, between two journals, is mounted a horizontal shaft ;and between the journals this shaft is fitted to receive a second shaft, perpendicular to the first. Upon the front end of the frame supported by the second shaft are two U-shaped irons of heavy section, and upon the rear end is a cast iron reservoir for holding the water under pressure used in connection with the drills. The two U-irons carry at their ends a strong steel beam, which support the movable castings carrying the three drills.

Each drill is operated by a separate electric motor, through an extensible rod with universal joints, and the three motors are located under protecting boxes on a frame-plate carried by the U-bars. The carriage thus occupies the least possible space, longitudinally. An endless screw, acting upon a gear wheel, adjusts the beam carrying the drills to its work. When working, this beam is wedged between the sidewalks of the heading by means of screw-jacks. When the first row of holes has beeen drilled, the transverse axis of the carriage is used to change the vertical position of the beam supporting the drills. The ,total weight of this carriage was about 5,940 lbs.; the drills weighing 726 lbs. and the three motors, 660 lbs.

Each motor developed 3 H. P. at a speed of 1,450 revolutions per minute, reduced to 209 revolutions by means of cog-gearing; and to the larger wheel in this gear was attached the transmitting shaft, with universal joints, which set in motion the drills.

The drills used were of the Bornet rotation type, through which water under pressure was injected, for the purpose of forcing the drills against the rock, cooling the drill points and carrying away the refuse. This type of drill, well-known in the French mines, is fitted with a device for stopping the advance movement of the drill when the rock exceeds a certain limit of hardness, and thus the drill points are relieved from an excess of pressure. The drills here employed had a forward movement of 2.62 ft. and drill holes were from 1¾ to 2 ins. in diameter. The cutting edges revolved at the rate of 53 revolutions per minute, and the rate of advance was about 3 ins. per minute, a result touching that of the best European percussion drills. The water used with the drills came from a small rotary pump, operated by an electric motor, and placed at the main generating station; this pump furnished water through a pipe, under a pressure of about 28½ lbs. per sq. in. Another motor of the same type operated a ventilating fan used in rapidly driving out the smoke after firing a round of holes. This ventilator was mounted on a carriage, and after being drawn up to the face of the heading it was united by a canvas tube to a large pipe through which the smoke was discharged.

As a general result, each drill required 3.3 net HP. The line loss, due to the resistance of the conductors, was about 1 per cent. of the total loss for each 328 ft. of distance. The working force comprised 8 men under a mining foreman. According to the nature of the rock, 12 to 14 holes were drilled from 2.6 to 4 ft. deep; and the total time consumed in making one advance, from the time of placing the carriage in position for drilling to firing the holes, and clearing away the debris and the smoke, varied from 3 to 7 hours; the average time was 4h. 30m., equivalent to five "advances" in a day of 24 hours. The greatest daily advance was 13.8 ft., and the average advance was about 10 ft.

While the article does not describe the details of the Bornet drill employed, it is evidently of the Brandt type; or a rotary drill with steel bits, pressed against the rock by hydraulic power with sufficient force to crush into the rock. The Brandt drill performs its work by heavy pressure and slow, rotary motion; the rock being supposed to be crushed and broken, but not pulverized and shaved. In the Brandt drill, water under pressure admitted to the drill cylinder pressed the drill bit against the rock, and rotary motion was imparted by two small hydraulic engines mounted on the rear of the drill. The drill rod was made of long and short sections of tubes quickly joined together by screws, as the screw in the shell of the drill itself only admitted an advance of 1.1 ft. The drill-bit has 3 to 5 points, or curved inclined planes; and the whole drill is hollow, admitting of a core of rock being taken out, and through the hollow water was passed to keep the drill points cool and wash away the broken rock. This drill works practically noiselessly, the crushing of the rock alone being heard.

A NEW SYSTEM OF SUBMARINE TELEGRAPHY.

A system of apparatus adapted for the sending and receiving of telegraphic signals on long lines of cable was patented on May 25 by Mr. Charles G. Burke, and a representative of this journal has had the opportunity of witnessing its operation at the office of the inventor, No. 48 Broad street, New York City. It seems to be capable of much more rapid work than the system now in use, and the record of the message made by it, both at the sending and the receiving ends, is far more legible than that made by the siphon recorder, now used in receiving messages on the Atlantic cables. The object of the invention and a statement of its means of operation are given in the following extracts from the patent specification:

In long lines, of large static capacity, the effects of induction render rapid working a matter of great difficulty, and have heretofore proved an obstacle to the practical transmission and receipt of distinct signals of sufficient variation in length to be recognizable as the corresponding to the characters of the Morse code. This is due to the fact that the discharge of a cable or a circuit of large static capacity is relatively less rapid and complete after an impulse required to produce a dash than after such momentary impulses as are sufficient to produce Morse dots, so that in the case of mixed signals composed of a succession of dots and dashes this relative inequality in the time and degree of discharge of the line causes such distortion and irregularity in the signals as received or recorded as generally to render them unintelligible. The universal practice is now to send short impulses of one polarity to produce effects in the mirror instrument or characters on the siphon-recorder corresponding to Morse dots and similar impulses of the opposite polarity for dashes. There exists, however, the serious objection to this plan that the signals can only be distinguished by a skilful determination of their direction and extent of deflection from a given point or line, and the records are necessarily more or less illegible. Moreover, it is difficult to relay or re-transmit signals automatically the elements of which are of opposite polarities, particularly where the line conditions demand the use of very sensitive instruments, such as are now employed on cables.

According to my invention, the recorded signals at the receiving-station are not caused by the electrical impulses which I transmit over the line, but by mechanical means which operate only in the intervals between the passage of impulses over the line or after such impulses have ceased. These impulses, moreover, are of uniform duration and occupy no longer time than is sufficient for the accomplishment of their purpose. At the sending end of the line I employ means by which electrical impulses of uniform duration may be transmitted, and by these impulses I define at the receiving-station, the beginning and ending of time periods of predetermined lengths. At the receiving end of the line I employ a recording instrument organized to respond to these impulses and to denote and record by mechanical means the time intervals occurring between them. As these intervals may be made shorter to correspond with dots and longer to correspond with dashes, it follows that any desired succession of characters readable as dots and dashes may in this way be transmitted and recorded by current-impulses of uniform duration.

The patent specifications are illustrated by several drawings, which are explained in detail, but the general principle and the leading features of the invention may be shown by the drawing here reproduced, which shows a transmitting instrument at one end of the line, and a receiving instrument at the other. The receiving instrument is shown at the right. A paper tape is caused to move at a uniform speed beneath a printing roller, which normally rests upon it, and above which is an inking roller. A continuous line is thus printed upon the tape, except when a current impulse is received through the line. This energizes the magnet, attracts its armature and so breaks the contact of the printing roller and the tape, leaving a space in the inked line corresponding to the duration of the impulse. The impulses may be sent into the line by means of the ordinary sending key, but the preferred method is to use a perforated tape, shown in the sketch at the left. The tape is fed at a uniform rate below the trailing point (b), and the lever (a) falls each time a perforation passes under the trailer, placing the battery in circuit with the line and therefore sending an impulse of a duration corresponding to the length of the perforation. As the perforations are mere pin holes the time of contact is exceedingly short.

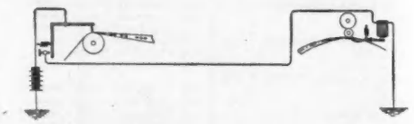


Fig 1.—Apparatus for Cable Telegraphing.
Invented by Charles J. Burke, 48 Broad St., New York.

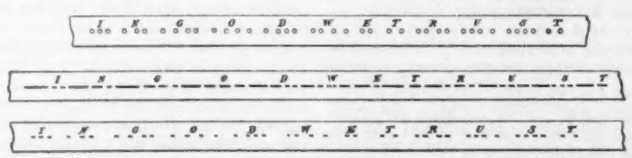


FIG. 2.—SIGNALS MADE ON THE SENDING AND RECEIVING TAPES OF TELEGRAPHIC INSTRUMENTS.

The making of the perforations in the tape is

accomplished by either of two ingenious devices, in one of which the operator, who is a telegrapher familiar with the Morse alphabet, depresses keys corresponding to dots, dashes and spaces, thereby punching the desired perforations in the tape; and in the other, necessarily a more elaborate instrument, the skilled telegrapher is dispensed with, and any person who can operate an ordinary typewriter is substituted. This instrument has a series of keys corresponding to the letters of the alphabet, and it is used in conjunction with the first instrument. Depressing the key corresponding to the letter I, for instance, will cause a wheel to revolve which sends to the perforating instrument three distinct impulses, causing it to perforate three holes uniformly spaced, the two short spaces between the three holes corresponding to the two dots of the letter I in the Morse code. Depressing the key N, will cause another wheel to send three impulses, which will also cause the perforating instrument to make three holes, but the space between the first two will be greater than that between the second and the third, these spaces corresponding to the dash and dot which form the N of the Morse code. Quoting again from the patent specifications:

On the diagram (Fig. 2) illustrating the tape T, are shown a series of letters, and beneath them the perforations are indicated which would be necessary to produce such letters. At T' is shown a tape with the record thereon which would be produced by the recorder, and on which the regular characters of the Continental code are seen between the longer lines which indicate spaces. At T" is shown a tape with marks thereon which correspond in number and position with the number and time of the actual impulses transmitted over the line.

The perforated strip for transmission is so prepared that a difference in the spaces between perforations equal to the distance which it is intended to separate letters and words in the record is provided, so that these distances will be indicated by marks on the receiving-paper longer than those which represent dashes. By this plan all letters are isolated or separated from one another by marks distinctly longer than that for a dash, while words are separated by marks distinguishably longer than those between letters.

In addition to the features of the invention above described, a number of others are described in the patent, such as variations in the style of perforations in the sending tape methods of relaying messages, etc. The most important claim probably is his method of "clearing the line" by sending through it for an exceedingly brief period after the transmission of each impulse, another impulse of opposite polarity. By this means, in connection with the system of telegraphing only a series of impulses of brief duration, instead of the ordinary dot and dash impulses, the difficulties of cable and other long distance telegraphing which are due to induction and capacity of the line are avoided, and the practicable speed of cable telegraphy greatly increased. The patent has five claims, of which the two following cover the leading features of the invention:

1. The method of telegraphing herein described, which consists in transmitting over a line electrical impulses of uniform duration at variable intervals and indicating or recording at the receiving station the intervals between impulses or the periods of no current on the line, as set forth.

5. In a telegraph system the combination with an instrument adapted to make and break an electric circuit by means of a perforated strip, of an instrument controlled or operated thereby and adapted to transmit over the line two immediately successive alternating impulses corresponding to each of the unidirectional impulses produced by the passage of the trailer over the perforated strip, as set forth.

SLUICE BOX AND FLOOD GATE CONSTRUCTION; FRASER VALLEY RECLAMATION, BRITISH COLUMBIA.

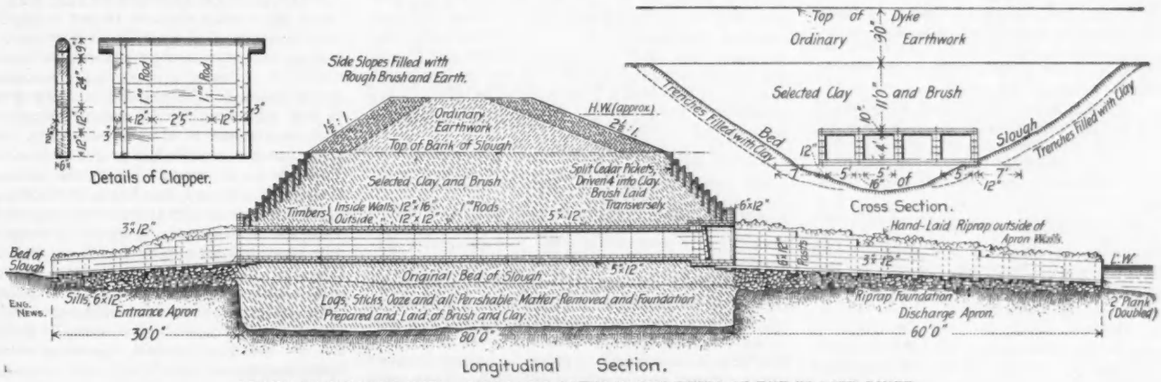
In the reclamation of the delta lands of the Fraser River, in British Columbia, (which work was noted in our issue of Dec. 31, 1896), engineers find the most difficulty in the satisfactory design and construction of the sluice boxes and flood gates used in connection with the dykes. On April 8, 1897, Mr. R. E. Palmer read a paper on this subject before the Canadian Society of Civil Engineers, of which the following is a brief extract:

The sluice boxes here illustrated were built in 1893, to replace three other boxes previously destroyed by freshets coming from the Matsqui Prairie. Four separate boxes were used at this point, identical in design and each was 80 ft. long, 26 ft. wide, by 5 ft. 8 ins. high, outside measurement, and each divided into four openings of 4 × 5 ft. The entrance apron is 30 × 40 ft., and the discharge apron is 60 × 40 ft. All timber used was rough sound cedar, with clappers, or doors, of dressed Douglas fir, and all the spikes used were galvanized. Each box contained about 90,000 ft. B. M. of timber.

The most important part was the setting of the box. At this point in the Fraser River there is a rise and fall of tide of about 4½ ft. A temporary dam was first built a short distance above the site of the box, a take-off ditch was dug, and the part of the slough below the dam was then pumped out. Considerable trouble was experienced in the building of this temporary dam owing to the treacherous nature of the soil, but the dam was finally constructed with a crib of logs, sheet piling, earth and loose hay and brush. After the slough was pumped out the bottom material was tested at the site of the box. The first two feet consisted of ooze, slime, brush, stumps, etc.; beneath this was from 4 to 6 ft. of silt, of a bluish color containing small particles of mica and very gritty to the touch. This material when undisturbed is impervious to water, but becomes a quicksand when exposed to the action of water under pressure. Beneath this was a bed of fairly coarse red sand. An examination of this material explained the failure of the previous boxes. These had been built in the form of coffer-dams, constructed by driving rows of sheet piles braced to ordinary piles, and with the intervening space filled with earth or clay. These piles had penetrated the bluish silt and were driven into the red sand; when the water acquired the necessary head on the outside, after closing the gates, it followed down the piles through the silt into the sand and up on the other side. The intervening earth was soon washed out, a channel was formed beneath and the collapse of the whole structure followed.

In building the new boxes it was decided to lay the foundation on the bed of silt without disturbing it any more than was necessary. All the ooze, logs and decayed material were first removed; then a bed of clay, 2 ft. thick, was laid down in layers a few inches in thickness, carefully levelled and well tamped and rammed down. This clay layer extended 80 ft. in length, and on top of the clay were laid rows of brush extending across the foundation with butts towards the end; all standing branches were nicked so as to make them lay close. On top of the first row another was laid, somewhat after the manner of thatching, and this was continued until the clay layer was thus covered for a legth of 50 or 60 ft. Another layer of clay, from 1½ to 2 ft. thick, was now placed over the whole foundation and thoroughly compacted by horses and levelled off. On top of this second clay layer was another thatching of brush, similar to the lower layer, but commencing this time at the opposite end of the foundation and with the butts reversed. This second brush layer also extended over about two-thirds of the length of the foundation and thus overlapped the first layer. Care was taken, however, that there was always a good layer of clay between the brush layers, so that the brush should nowhere be continuous throughout the length. On top of the second layer of brush was another clay layer, and this was continued until the proper height was secured for the box proper.

The foundation was finally levelled off and the bottom planks of the box floor laid upon them, close together and well pounded into place; upon this the box was built, as shown in the figure. When the box was in place the space between the sides and the banks of the slough was filled with layers of clay and brush, as before described, and without continuous brush layers. Key walls were used to knit this filling into the bank. This same construction covered the box itself to the level of the banks of the slough; with the exception that above the level of the box the slopes at each end were carried up by driving split cedar pickets, about 3 ins. diameter and 6 ins. apart, 4 ft. into the embankment. Each row of pickets was one foot higher than the preceding one and one foot nearer the centre of the box, thus making an end slope of 1 on 1. Behind, or inside each row of pickets, brush was laid transversely with the box, to keep the clay in place. Above the level of the slough bank an ordinary earth embankment was built up to the level of the river dyke, or 2 ft. above maximum high water.



DRAINAGE CULVERT WITH AUTOMATIC GATES IN THE DIKES OF THE FRASER RIVER.

"Side-hung" gates, built in pairs and closing at the center of the opening, give less trouble in this connection. The floating debris, not being dragged to the bottom of the gate, has a chance to go through, and the gates being evenly balanced move easily. The objection to side-hung gates is that they will sag, unless well designed and strongly built. The general design of the top-hung gate is shown in the drawing presented herewith.

One of the boxes built by the writer of the paper and here described was subjected to a freshet in July, 1896, which reached within 3 ft. of the disastrous flood level of 1894. Though the work was barely completed, no damage of any kind was done.

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With this issue we illustrate and describe two new hydraulic dredges, designed, for use on the Mississippi River, in the office of Major Thos. H Handbury, Corps of Engineers U. S. A., at St. Louis, Mo., and now being built by the Bucyrus Company, of South Milwaukee. As these dredges are intended for use on a portion of the river where there is little or no clay, or other hard material, the rotary cutters have been omitted and powerful water jets are depended upon for stirring up the material to be excavated. A novel feature of the efficiency test for the acceptance of these dredges is the limiting of the percentage of "lost time" chargeable to delays occasioned by faulty machinery, or the general operation of the plant covered by the contract. According to the last annual report of the Chief Engineers, the government has had some unsatisfactory experience in the building and testing of large dredges of this type on the Mississippi River, and the provision referred to is evidently a direct outcome of this experience. The Report for 1896 states that, on Feb. 23, 1895, the government entered into a contract with Mr. Lindon W. Bates, of Chicago, Ill., for the construction of a large hydraulic dredge, since known as the dredge "Beta," and fully illustrated and described in our issue of April 23, 1896. The contract requirements called for a capacity of 1,600 cu. yds. of sand per hour delivered 1,200 ft. from the dredge, a width of hull not exceeding 40 ft., and a length of hull so adjusted by the weights to be carried as to secure a draft not exceeding 4½ ft. The report of the Mississippi River Commission states that after annoying delays, due to defects in the dredge as delivered, ten tests were made, "under special conditions directed by the contractor, in order to secure the greatest possible output for a very short time." When actually working the dredge proved to be of immense capacity, far exceeding the contract requirements; the average rate of sand delivered per hour was 4,021 cu. yds., and the average percentage of sand delivered was 23.02. This experience convinced the Commission that a great capacity could be given to machines of this type for purposes of bar removal; but it also convinced the Commission that similar machines would in the future have to be designed and tested under more stringent regulations. The "Beta" drew 6½ ft., instead of 4½ ft. of water, when trimmed for work, and this feature alone almost destroyed her usefulness; the boilers were of insufficient capacity, and the design of the machinery was so faulty that many parts of the plant broke down from the strain put upon them by the dredging operations. The most serious fault, however, was the lack of capacity for continuous work. In a detailed report of the time distribution, from Jan. 16 to April 10, it is shown that the first attempts to operate the dredge were attended with great difficulty and delays arising from defects in design and construction. In 160 testing hours in January, 71 h. 30 m. were devoted to "repairs and necessary changes;" in 292 hours in February, 183 h. 30 m. were so consumed; but by March and April matters were so adjusted and corrected that out of a total of 410 hours only 34 h. 20 m. were thus charged. But the aggregate for the four months showed a loss of very nearly 30% of the whole available time due to the causes named. The Commission reports that "these defects in the dredge, together with the great delay in her completion, made the arrangement of terms for her acceptance a subject of difficulty;" and it, therefore, advised that the government should only accept it on condition that charges be made against the contract price sufficient to remedy those features in which the dredge departs from, or falls short of the requirement of the contract. It is evidently to avoid a repetition of this experience that the government, in inviting proposals for new dredges, specifies that not more than two official tests shall be made, and that acceptance shall depend upon the actual working capacity of the dredge for a specified time, with a limit absolutely fixed to the proportion of time which may be lost through defects in the machine.

The recent report of the New York Chamber of Commerce, showing that the commerce of this port for 1896 had decidedly decreased and was less than for any year since 1889, has awakened discussion as to the causes of this decline in business. The increased tonnage of transatlantic steamers in late years, and the fact that the entrance to our harbor is tortuous, comparatively narrow, and only 30 ft. deep, has certainly had much to do with the departure of trade to more favorably situated ports. These unfortunate conditions in our harbor are recognized in the present effort to straighten the channel and to secure a 35-ft. depth at low tide, with a width of at least 1,000 ft. According to Col. Gillespie's estimate of last January, made to the Secretary of War, this improvement would cost about $1,740,000, and re-surveys are now being made by Lt. Col. Ludlow with the view of obtaining fuller information, and if possible, of lowering the cost.

The lack of proper dock facilities on the water front of New York is another serious cause for complaint by steamship companies and by shippers generally. And while the New York Dock Department has now the authority and money available, and has completed plans for what will be a vast improvement upon present conditions on the North River, some other equally essential steps in inducing trade to come this way seem to be neglected. The operations of the existing laws for the leasing of piers is opposed to the interests of New York as a commercial port. Instead of renting these piers under fixed regulations at a certain amount per square foot, as is the practice in Liverpool and other great centers of commerce, the Dock Commission here seems to act upon the principle of imposing all the tax that the commerce will bear; and the result is that commerce goes elsewhere, to points where other cities give away privileges that must be fought for here.

Another, and perhaps the most potent, factor in retarding the growth of the commercial activity of this port is well expressed by Erastus Wiman, in an interview in the New York "Tribune." It is one of the axioms of well conducted trade that the cost of transfer from lines of land transportation to the hold of the ship should be reduced to a minimum. And for this reason, in all great ports, railways have close and direct communication with the docks and ample warehouses for the storage of goods are situated close to both. In this connection the commerce of New York is very badly handicapped. All but one of the great trunk lines terminate on the other side of a wide river, where storage and trans-shipping facilities do not exist, and costly transfer by lighters becomes a necessity. The ample harbor facilities of Brooklyn are still further removed from the railways, and Mr. Wiman illustrates the effect of these conditions upon trade by stating that, at times, at a 2 ct. rate on wheat per bushel, or $20 per car, from Buffalo to New York, $18 out of this $20 must be paid for lighterage after the wheat reaches New York, leaving only $2 to the railway for a 500-mile haul. Mr. Wiman estimates that an aggregate tax of $10,000,000 annually is thus imposed, against which the commerce of the port has to contend. Then, too, the city area facing our docks, is given up almost solely to small trades and to saloons, instead of being covered with roomy warehouses for containing in storage the products of all parts of the world. The complete separation, in New York, of docks, railways and warehouses, also compels the use of drays to an extent practically unknown in other ports, and imposes another tax on the handling of goods, says Mr. Wiman, that amounts, perhaps, to $30,000,000 annually.

Under these conditions, which all must admit as being practically true, it is not remarkable that the Chamber of Commerce of New York finds itself compelled to report a declining trade, and a diversion of business to other ports which are better equipped for the transfer of freight from land to sea, and are offering special inducements in port regulations to attract this trade. The deepening and straightening of the entrance to New York harbor is necessitated by the increase in the size of ships from a maximum of 5,000 tons to one of 10,000 tons or more; and this improvement will doubtless soon be ordered by the government. The new piers being built by the Dock Department of this city will add largely to the facilities for steamships on the North River, and the work upon them cannot be too soon completed. The belt line of railways parallel to the docks is recommended by the board of experts reporting to the Dock Commission, and this board very properly prefers a surface system of tracks to an elevated structure, as being better adapted to the needs of transfer. But, while these tracks will directly connect with the New York Central system of railways, the other great trunk lines, on the other side of the North River, must still depend upon floats and towing for the trans-shipment of heavy freight. It is true that efforts will be made to facilitate the handling of these floats; but there is no doubt that the extra handling thus necessitated imposes a tax upon commerce which does not exist at ports where the railways can come directly to the ships. This difficulty may be sometime met, in part at least, by the construction of a North River bridge; but it will always remain as an element of added cost in handling goods, and it must be offset by every other possible concession by those controlling the regulation of New York commerce. It should be realized that the actual amount received for the rental of a new pier by the City of New York bears an insignificant relation in actual financial returns to the better encouragement of trade at this port; and it is the part of wisdom to make our port regulations as liberal as possible and at least to offer equal inducements with other cities now seeking to profit by existing conditions at this place. What the reverse policy means, coupled with the other causes named, is shown in the statement made that whereas, in the last eleven months, the increase in grain shipments from the whole country amounted to 72,000,000 bushels, and New York, in proportion to the record of previous years, should have received at least 50% of this total, or 36,000,000 bushels, the startling fact remains that the increased shipment of grain at this port only aggregated 250,000 bushels in the period named. This loss of business is a serious matter and calls for the deepest study of causes, and an earnest effort to regain lost ground.

THE DISTRIBUTION OF ELECTRIC CURRENT FOR RAILWAY PURPOSES.

In our issue of July 1 we gave a short account of the contract which the General Electric Co. has secured for the electric equipment of the new Central London Ry., and we presume many of our readers noticed that in the equipment of this line an entirely new departure has been made in the use of a three-phase alternating current for distributing electric energy from the power station to sub-stations along the line. We are aware that the Lowell & Suburban Ry. is using a three-phase transmission system, (which was described in our issue of Oct. 17, 1895), but the Central London installation is so different in several important respects, notably in the use of generators which deliver a high potential current and do not require the use of step-up transformers, that it is correctly described as a new system.

The point that we apprehend has puzzled many of our readers who have critically studied our description of the plans for the Central London Ry. is, why was the high potential transmission adopted for so short a line, only 6½ miles in length? It is, of course, well understood that when we come to long-distance electric railroading, something different from the ordinary 500-volt street railway current must be adopted or the cost of copper and the heavy line losses will make operation an expensive matter; but in this country a 6½-mile electric railway is considered short, rather than long, and even for heavy railway work like that for the Chicago elevated roads, and the New York, New Haven & Hartford, the 500-volt current has been considered good enough for considerably longer distances.

Why, then, did the able engineering staff of the General Electric Co., headed by Mr. Chas. Steinmetz, adopt for so short a line a high-potential transmission, which requires two transformations before it is delivered to the conductors along the line? The only reasons which have been published are that it is desired to avoid any variation in the voltage which might noticeably affect the brilliancy of the lights in the cars and stations, and that the English Board of Trade has established 10 volts as the maximum variation in potential which will be permitted. But these reasons seem hardly sufficient. With a generating station of such large capacity, the expense either for first cost or for maintenance would hardly be very much increased if two generating stations were built instead of one, and these might be so located as to make the maximum distance to which current would be conveyed from a given point on the line only a little over 1½ miles. Again in a tunnel road the use of rolled steel instead of copper for conductors makes it possible to provide sufficient conducting section to reduce variations of line voltage to a very small amount and yet not reach extravagant figures in cost. Still again, if absolutely unvarying voltage is a requisite for the lamps, it would be an easy matter to light them from a separate circuit from that furnishing the power.

Of course there may be, and very likely are, good reasons why these plans could not have been adopted. The cost of a station in another location might have been so great as to be prohibitive for example, or the English authorities may have insisted that the work should be done in a certain way. We do not know whether the General Electric Co. was given a free hand or not in the selection of its design; but whether it was or was not, it may be of interest to point out some advantages which the new plan of current distribution certainly possesses. The great advantage, of course, is smaller variation in voltage, smaller loss in line, and smaller expense in line conductors. The smaller drop in voltage means higher efficiency in the motors on the locomotives. To put the above in actual figures, by transmitting a given power at 5,000 volts instead of 500 volts, we have to provide for only one-tenth the quantity of current, and since the loss in transmission varies as the square of the current it will be seen that a great saving is made.

To offset these advantages we have the first cost and cost of maintenance of the step-down transformers and the rotary transformers which charge the alternating current to direct current at each of the four sub-stations, and the loss in these machines. This loss, however, is not very high. Static transformers in large sizes when working under ordinary conditions, vary in efficiency from 97% to 98%, with an average of 97.5%. Under the same conditions, a rotary converter varies between 91% and 95%, with an average of 93%. Combining these efficiencies we find that the total loss in both sets of converters will average only a little over 9%.

It will be evident from the preceding discussion that the relative economy of the two methods of distribution in the case under consideration is not a matter which can be settled offhand. Only actual comparative estimates of the two systems would determine it; and to make such estimates such matters as the relative first cost, cost of maintenance and reliability of the alternating and the direct current generator would have to be ascertained. The probabilities are, however, that the balance between the two systems in the case of the Central London Ry. is not very far from even; but if this is the case, however, it is apparent that on lines of much greater length, not a few of which are already in operation or contemplated in the United States, the alternating system would have a great advantage; and we may expect to see its use rapidly extend during the next few years.

LETTERS TO THE EDITOR.

Printer's Ink on Tracing Linen for Blue-Prints.

Sir: In your issue of June 24, there is a description of an elaborate mehod of preparing ink for printing press, on tracings, and a statement that ordinary ink would not dry for several months. In our office we use ordinary, first-class printer's ink, and can dry it in an hour or less, by thoroughly sprinkling it with magnesia.

Yours truly, T. Kennard Thomson,
Dutton Pneumatic Lock and Engineering Co.
New York, N. Y., July 14, 1897.

A New Steel Excavating and Wagon Loading Machine.—Correction.

Sir: Referring to the article published in your issue of June 24, describing a new steel excavating and wagon-loading machine, we wish to state that it requires twelve horses for successful operation instead of from four to eight as stated in your article. We would also note that the machine is well adapted to other purposes besides loading wagons. It is extensively used in making irrigation ditches, where the material is to be deposited at the sides, and in building up highways in low ground. Elevators of different length are used according to the distance the earth has to be raised.

Very truly yours,
Western Wheel Scraper Co.,
C. H. Smith, President and General Manager.
Aurora, Ill., July 12, 1897.

Direction and Velocity of the Wind During the Pittsburg Fire of May 3.

Sir: In Engineering News of May 20, you published an interesting account of the fire at Pittsburg, Pa., but neglected to mention either the direction or the strength of the wind, both of which points are, it seems to me, of considerable importance in judging of the relative resistances of the buildings to the fire, and I would esteem it a favor if you would republish Fig. 1 of this article with an arrow indicating the direction of the wind and its force

Yours truly,
Geo. Hill, M. Am. Soc. C. E.
New York, N. Y., June 10, 1897.

(In response to an inquiry the local forecast offical at Pittsburg, Pa., sends us the following table showing the character of the wind movement from 10 p. m., May 3, to 8 a. m., May 4, 1897:

Hour.	Direction.	Velocity, miles pr hr.	Hour.	Direction.	Velocity, miles pr hr.
10 p.m.	West	7	4 a.m.	Southwest	9
11 p.m.	"	4	5 a.m.	"	9
12 m.	Southwest ...	5	6 a.m.	"	7
1 a.m.	" ...	4	7 a.m.	West	7
2 a.m.	" ...	4	8 a.m.	"	9
3 a.m.	" ...	7			

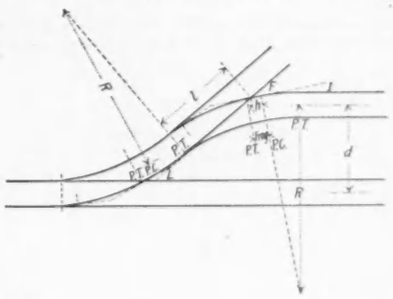
The two Horne buildings being nearly west from the Jenkins grocery store, and the Methodist book building about north, it will be seen from Fig. 1 of our issue of May 20, that the wind carried the fire toward the Horne buildings.—Ed.)

Two Track Problems and Their Solution.

Sir: The following two track problems and their solution may possibly interest some of your readers:

(1) In putting in a ladder track, at an angle with the yard tracks greater than the frog angle, to find the intertrack distance required for a given radius of connecting curve or vice versa. Let

h = theoretical point to heel of frog.
l = lead of turnout on straight line, that is, theoretical point of switch to theoretical point of frog.
F = frog angle.
L = ladder angle.
I = intersection angle = L—F.
R = radius of center line of connecting curve.
g = gage of track.
d = intertrack distance (center to center).



Then

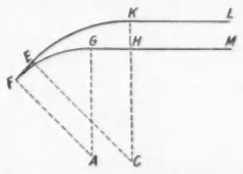
$$d = (R + \frac{1}{2}g)\ \tan\frac{1}{2}I\ (\sin I + \sin F + \sin L) + h\ (\sin I + \sin F) + l \sin L.$$

or

$$R + \frac{1}{2}g = \frac{d - h\ (\sin I + \sin F) - l \sin L}{\tan\frac{1}{2}I\ (\sin I + \sin F + \sin L.)}$$

These formulas can be readily solved on the slide rule with sufficient accuracy for field work.

(2) Given two parallel tangents, KL and HM, a given distance apart (KH), the radius (AG) of a curve leaving the lower tangent, to find the radius of a curve leaving the



upper tangent a given distance (GH) back of the other curve, which can be connected with it by a tangent (EF) of a given length.

Let

$r = AG$ $\quad b = GH$
$a = KH$ $\quad t = EF$
$R = CK$

Then,

$$R = r + \frac{a}{2} + \frac{b^2 - t^2}{2a}.$$

This problem is of service in special curved work, where it is desired to introduce a piece of tangent in order to have one side of a switch straight, a necessary condition, as the manufacturers do not attempt to curve both sides of a switch point.

Yours truly,
Wellington B. Lee, Assoc. M. Am. Soc. C. E.
Hillburn, N. Y., June 17, 1897.

A New General Formula for Determining Unit Stresses in Masonry Structures.

Sir: In your issue of July 1, Mr. E. Sherman Gould invites criticism upon a new general formula for determining unit stresses in masonry structures. This proposed new formula is not to be recommended. In practice formulas (1) and (2) will not lead to any great complication, and they are never needed so frequently that it is necessary to substitute a simpler but less reliable formula in order to save time. The new formula (3) is based upon a supposed uniform load throughout both sections of the base. This is certainly far from the truth and the idea that this formula will give more practical reliable results than formula (1) for $d < \frac{L}{3}$, illustrated by a numerical example, is erroneous.

Fig. 1 represents the reactions, really to be expected; Fig. 2, their values according to formulas (1) and (2); and Fig. 3, their values according to the assumption of Mr. Gould. From this it will appear that, although the pressure in the short section is somewhat more uniformly distributed than is supposed in formulas (1) and (2); this is not the case in the other section. Figs. 1 and 2 agree therefore better in the total pressure borne by each segment; and the maximum pressure calculated from formula

(3) will be farther from the truth than formulas (1) and (2).

The curve in Fig. 1, will depend upon the elasticity of the material and details of construction; it will not differ much from the straight line and it seems superfluous to determine its equation, on account of the greater uncertainty that generally exists in the value of W. The maximum unit pressures taken from formulas (1) and (2) are already a little in excess of the really to be expected pressures; and there is no reason for taking the still greater values given by formula (3) for $d < \frac{L}{3}$.

The recommendation to keep the resultant pressure within the middle third is according to common practice,

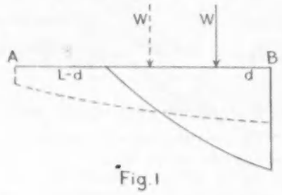


Fig. 1

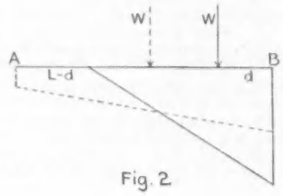


Fig. 2

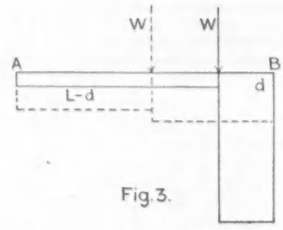


Fig. 3.

and the reason for this is the desire to avoid a tendency to tension, which will really occur, contrary to the assumption of Mr. Sherman Gould.

A careful reading of Trautwine (1895), pages 231a and 231b, where the same formulas (1) and (2) are demonstrated, with different notations, however, will convince any one of the superiority of the established theory for theoretical and practical purposes above the proposed new formula. J. J. Israels.

Denver, Colo., July 7, 1897.

(In accordance with our usual practice, we submitted the above letter to Mr. Gould for reply and append his answer below.—Ed.)

Sir: I am very glad to see the criticism, by Mr. Israels, of my proposed—or rather suggested—general formula for unequally distributed stresses in masonry. It will be observed that Mr. Israels advances still another theory, exemplified in his Fig. 1, as to the probable action of the stress, which he correctly states is more in accord with the usual formulas.

It must be borne in mind that no one claims that formulas (1) and (2) are more than plausible guesses. My suggested formula does not, therefore, run counter to any well-established principle, but is merely what appears to me to be a somewhat more rational guess at the truth.

I wish to say, in defence of my suggestion, that the two formulas (1) and (2) cannot in my opinion be correct, because, for one reason, there are two of them. When the vertical resultant of the forces exerted upon a mass of masonry cuts its base in the middle, we are all agreed that the unit stress is uniformly distributed throughout the base, and is equal to the total weight or pressure, divided by the total base. If from any cause the point of application is shifted from the middle of the base, the stress is intensified upon the shorter segment. We are all agreed upon this, also. To determine the degree of this intensified stress, the only data are, the weight, which does not change; the length of base, which does not change, and the length of the shorter segment, which does or may change. No matter how much or how little the point of application of the stress is shifted, the length of the shorter segment, d, is the independent variable upon the value of which the unit stress depends. Whether or no my suggested formula be the correct one, the correct one, when found, will be a single general one, and when plotted will not change, abruptly from a straight line to a curve, at a certain fixed point, namely for $d = \frac{L}{3}$.

Waiving (2), which agrees so nearly with (3) that it is unnecessary to dispute about it, one way or another, I write, say that (1) seems to me to be obviously incorrect, except for $d = \frac{L}{3}$ (which is the assumption upon which it appears to have been originally founded), in that it fixes the proportion of weight resting upon the shorter segment at the invariable figure of two-thirds, no matter how much the length of the shorter segment may vary. In (2) the proportion of weight varies with d, as it should do.

Now, I think we can bring the probable comparative correction of the suggested formula and (1) to a test, by assuming $d = o$. In that case we cannot of course determine the unit stress because, as I said in my previous letter, it then becomes infinite. But we can determine the total pressure, irrespective of the unit stress, when $d = o$, and the mass of masonry under consideration is, consequently, on the point of turning over upon the extremity of the base. Certainly, in this case, the whole of the weight is resting or about to rest upon the point or edge of rotation, and yet (1) still keeps it at two-thirds. What is the remaining third resting on? The suggested formula (3) gives in this case the entire weight as pressing upon the edge, which it appears to me is self-evidently the case.

I used this argument in my previous letter, making, however, $d =$ unity, when assuming the base to be relatively large, the result becomes practically the same.

For the convenience of those of your readers who may care to loc into this question for themselves, I repeat the three formulas, as follows.

$$P = \frac{2W}{3d}. \quad (1)$$

$$P = \frac{4W}{L^2}(L - 1.5\,d). \quad (2)$$

$$P = \frac{W}{L\,d}(L - d). \quad (3)$$

In which P = maximum unit stress in shorter segment; W = total weight resting on base; L = base, and d = shorter segment, or distance from point of application of W to nearer toe. Of these, (1) is to be used when d is equal to or less than $\frac{L}{3}$; (2) when it is equal to or greater than the same and (3) is general for all values of d.

In looking again at Mr. Israel's Fig. 3, I do not think it correctly represents my formula. The weight shown on L — d seems to be wrong.

E. Sherman Gould.

Yonkers, N. Y., July 13, 1897.

Notes and Queries.

J. P. E. asks: How many miles of underground telephone wires are there in New York City? How many miles of the above are long distance wires? Are there any difficulties in the use of long distance lines underground?

There are about 50,000 miles of such wire, only a very small portion of which are owned by the Long Distance Co. Connections can be made with the long distance lines over any local underground circuit.

Difficulties are experienced in the use of long distance lines underground or even portions of such lines. Capacity effects are introduced which alter the form of the sound waves being transmitted and destroy their characteristics. In the New York-St. Louis line the sounds c and t or e and i cannot be distinguished from each other.

The R. I. L. Co. writes:

Our attention has been called to a new process of galvanizing steel and iron and we understand certain parties either in New York or Philadelphia have bought the right to use same in this country. We desire to ascertain the name of company controlling this business in the East, and such information as you can give or get relative to the cost, etc., as compared with painting.

(We refer the inquiry to our readers.—Ed.)

In response to the inquiry of H. M., in our issue of July 1, regarding a coating for the soffits of stone arch culverts of inferior material to prevent their disintegration, Mr. Kenneth Allen, Principal Assistant Engineer of Sewerage Commission of Baltimore, Md., writes as follows:

Some years ago Dr. John C. Goodridge, Jr. ,of New York (whose address was 113 East 25th St.), perfected a process for reinforcing defective masonry in culverts, arches, abutments, etc., by the application to the exposed surface of a layer of beton, 6, 12 or more inches in thickness, according to the work. This process was employed by Mr. Octave Chanute, M. Am. Soc. C. E., when Chief Engineer of the Erie Railroad, to whom, with Dr. Goodridge, the writer is indebted for information on the subject, to strengthen various arches, culverts and tunnel linings on that road. The method proved to be very efficacious.

C. D. P. wishes to obtain statistics as to accidents caused by steamers or other vessels striking drawspans in the various navigable waters of the United States, and would be obliged to any one who would tell him where he would be most likely to obtain the information.

E. P. A. writes:

The following quotation is from an article in "Architect, Owner and Builder before the Law," by T. M. Clark, published three years ago: "Whether an engineer's plans and note books, which he uses for the benefit of his clients in the same way that an architect does his drawings, and of which, like the architect, he furnishes, as a rule, only tracings, would be regarded as the property of the engineer or the owner seems uncertain, and there appears to be no recorded case in which the question has been raised; but architect's drawings are more available for laymen's use, and occasionally form the subject of a struggle in the courts, which usually ends unfavorably for the architect." Are there any decisions of record upon this point? In my own practice I have always retained my note-books except when working on a salary, and have, with but two or three exceptions, retained working drawings, but have delivered the finished plans.

(We refer the inquiry to some of our readers.—Ed.)

NEW HYDRAULIC DREDGES FOR THE MISSISSIPPI RIVER IMPROVEMENT.

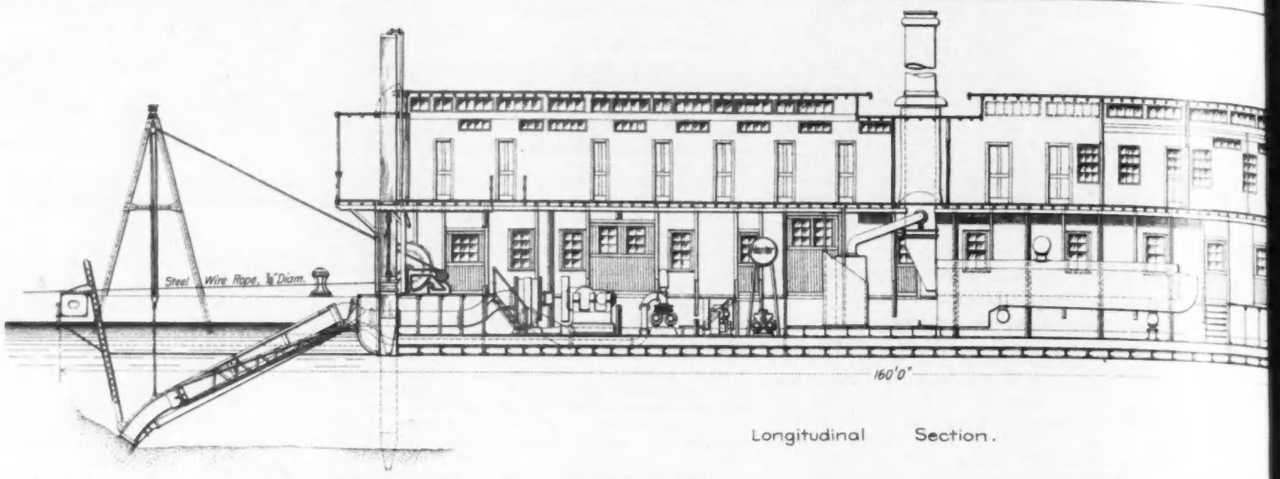
(With two-page engraving.)

In February last Major Thos. J. Handbury, Corps of Engineers, U. S. A., advertised for proposals for the building of two steel-hulled hydraulic dredges especially designed for low-water use upon the Mississippi River, between the mouth of the Missouri and the mouth of the Ohio River. In this reach there is little or no clay or hard material to be handled, and for this reason Major Handbury has adopted water jets at the end of the suction pipe for agitating the sand, as will be seen in the further description. The Bucyrus Co., of South Milwaukee, Wis., was the successful bidder for the construction of these hydraulic dredges, at the contract price of $102,400 for each dredge, and at this date their construction is well advanced.

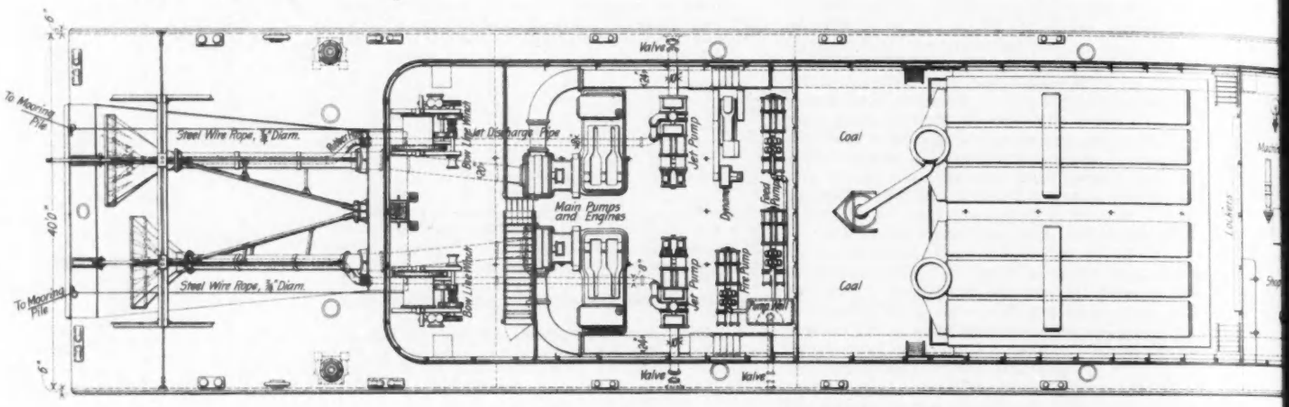
Each dredge is to be 160 ft. long, 40 ft. wide and 6 ft. 6 ins. deep, moulded dimensions, and when complete and ready for work it is expected to have a draft of 42 ins. The hull is to be built of steel throughout, in accordance with the rules of the American Shipmasters' Association, so far as these rules will apply. In the bow of the boat as designed is a well, 24 ft. wide at the forward end, 18 ft. wide at the after end, and 34 ft. long. The two projecting ends thus formed are strongly tied together by a box-girder, 36 ins. wide by 30 ins. deep, reinforced at the junctures by angles and cover plates. Along the front of this girder are riveted two angles, perforated with holes and intended for screen-bars, made of 3½-in. very heavy pipe, spaced 4 ins. apart in the clear and extending 9 ins. below the surface of the water. In the parts occupied by the pumping machinery and boilers the hull will be open, but the remaining parts will be decked over with steel plates.

At the stern the after deck projects 12 ins. for its entire width, and the guard thus formed is strongly connected to the hull by ten gussets of 5-16-in. plate. The entire hull is protected by white oak fender strakes, 6 ins. wide by 10 ins. deep, fitted to 3×3-in. steel angles and bolted to the hull by ¾-in. bolts. These fender strakes are laid on a thickness of hair felt throughout their length, the hull having previously received two coats of pure red lead and oil. The floor beams of the hull are 12-in. channels, spaced 24 and 30 ins. apart, and the side frames are 3×4-in. angles. Ten keelsons of 15-in. I beams extend throughout the hull, with double butt straps of ⅝-in. plate, and the two middle keelsons are stiffened throughout their entire length by 5-16-in. plates. The outside plating of the hull is to be generally 5-16-in. thick, reinforced at the ends by doubling plates. The deck plating is ¼-in. thick, with 5-16-in. plate at sides of boiler and engine hatches. Fore and aft and athwartship ¼-in. bulkheads divide the hull into eleven watertight compartments. In the forward part of the hull is a suitable well for the spud anchor, and the suction pipes are suspended from an A-frame built of I-beams and angles. As shown in the illustration, the entire hull is covered by a wooden deck-house for the accommodation of the machinery and men, together with machine shop, etc.

Each dredge is fitted with two centrifugal pumps, with 20-in. suction and discharge openings, located just aft of the well, and the discharge pipe from each pump is immediately enlarged to 24 ins. diameter. The pumps are single suction, with removable lining, and each pump is operated by a horizontal compound non-condensing engine, capable of making 200 revolutions per minute under or-

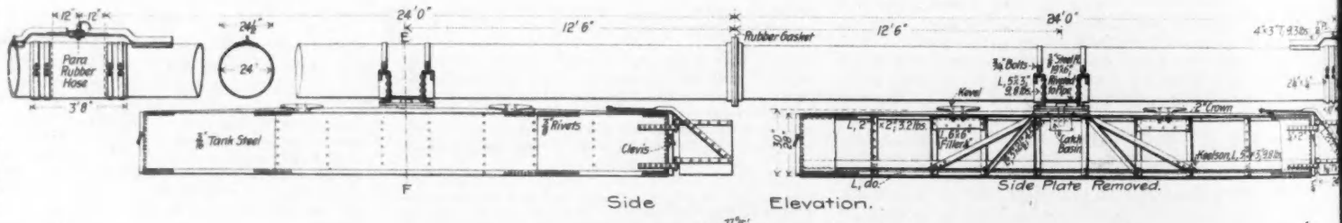


Longitudinal Section.

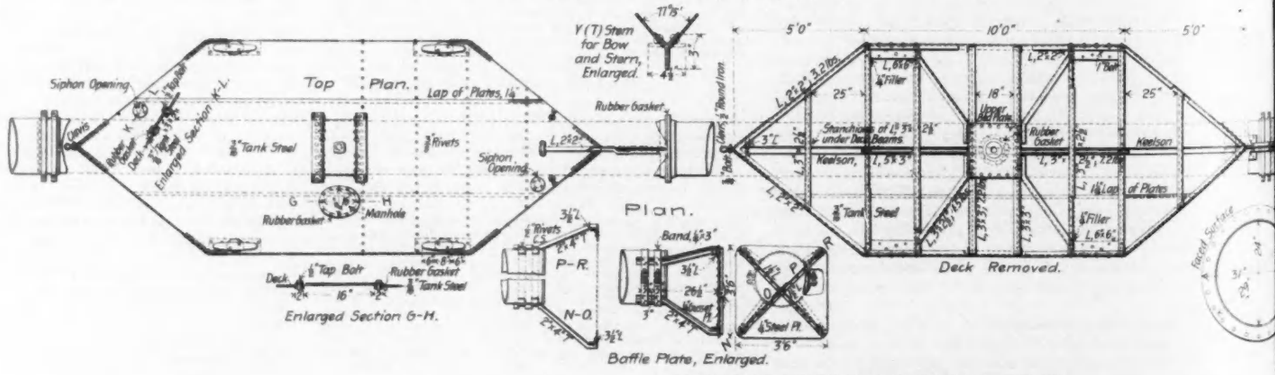


Sectional Plan.

GENERAL PLAN AND SECTIONAL ELEVATION.



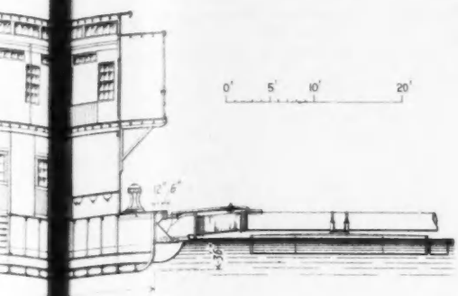
Side Elevation.

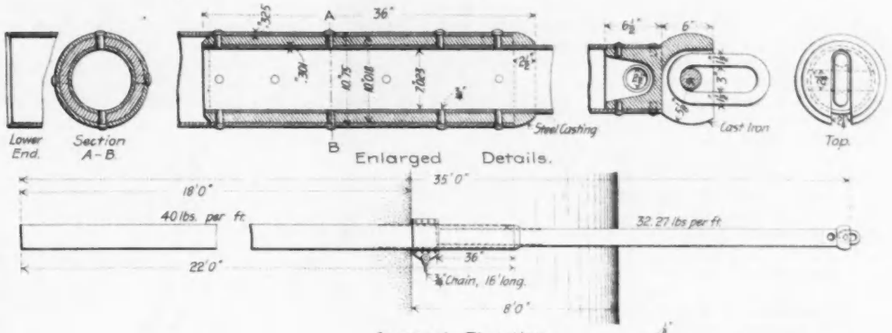


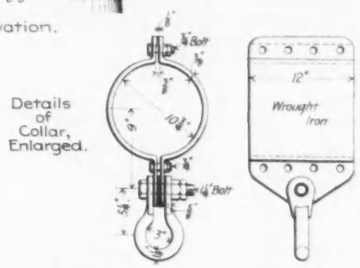
DETAILS OF PONTOON AND DISCHARGE PIPE.

HYDRAULIC JET PIPE DREDGE FOR E

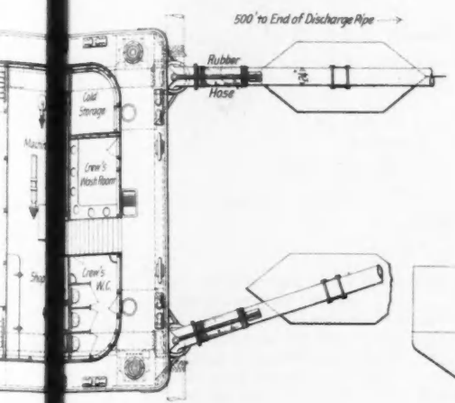
Designed under the direction of Major Thos. H. Handbury, Corps of E

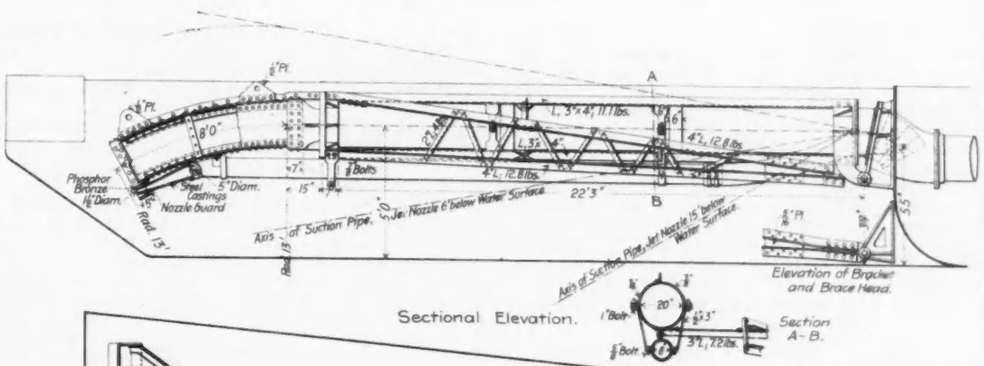




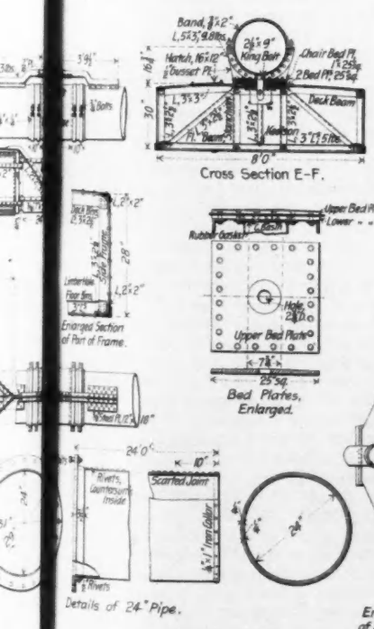


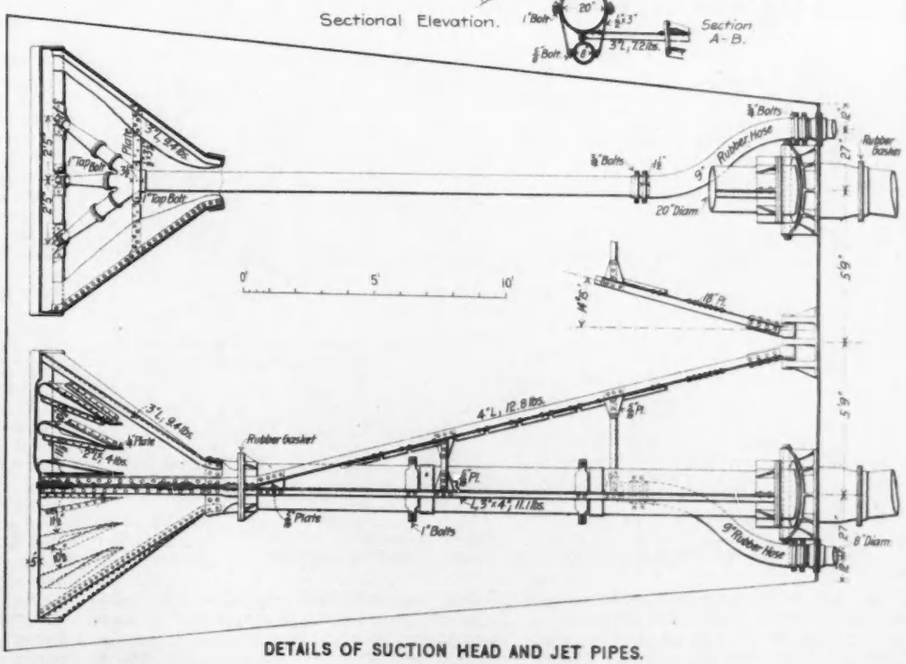
DETAILS OF HYDRAULIC MOORING PILE.





Sectional Elevation.





DETAILS OF SUCTION HEAD AND JET PIPES.

FOR E MISSISSIPPI RIVER IMPROVEMENT.

of E neers, U. S. A. The Bucyrus Co., South Milwaukee, Wis., Builders.

CHAS. HART & SONS, LITH., 20 VESEY ST., N. Y.

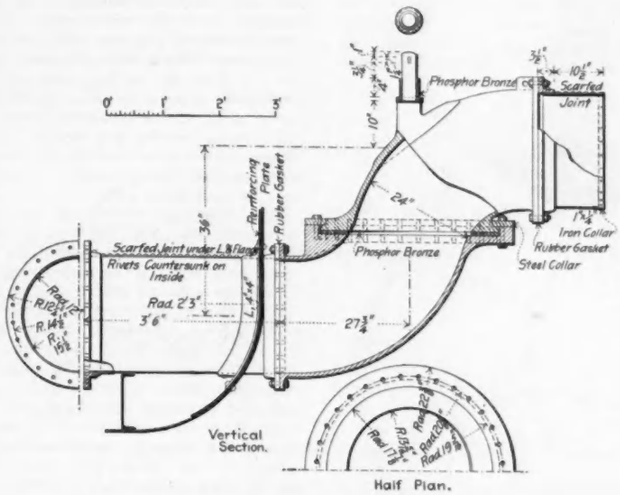
dinary working conditions, developing 300 actual HP. at 140 lbs. boiler pressure, and capable of maintaining through the suction and discharge pipes the velocity necessary to carry at least 20% of sand with 80% of water under a maximum head of 30 ft. The connecting rod from each cylinder is connected directly to the pump-shaft by a split coupling, with cranks at right angles, and each pump has a balanced fly-wheel. Steam is supplied by a battery of six boilers of the Mississippi River steamboat type.

The shell of the main pump is approximately 48 ins. diameter and 28 ins. deep, inside measurements. The pump-disk, or runner, is approximately 48 ins. diameter and is made of steel and iron, with double-ribbed flanges and three reversed curved wings or arms. The center clearance into the pump has about the same area as the suction openings, so as to readily pass obstructions and avoid the choking of the pump as much as possible. The ends of the wings are fitted with detachable extension wing-plates of mild steel, secured by bolts passing through slotted holes, and these plates are so curved as to reduce the friction against the pump shell. Fine, hammered steel is used for the shaft, and the inside and outside bearings are bushed with bronze. Each pump is guaranteed to handle 1,200 gallons of water per minute against a water pressure not exceeding 65 lbs. when running compound and supplied with steam at 150 lbs. pressure. When using the direct steam connections, with the above steam pressure, a water pressure not exceeding 110 lbs. must be maintained, though each pump is guaranteed to stand a working pressure as high as 200 lbs., and a safety valve is provided to relieve the steam when the pressure exceeds this amount.

With each main pump is a jet-pump for applying water under pressure, through nozzles, to the sand at the entrance of the suction pipes. These jet-pumps have two 8-in. high-pressure cylinders and two 12-in. low-pressure cylinders, with two 12-in. water plungers, all 10-in. stroke. There are also two Worthington plunger feed pumps, with 4½-in. cylinders and 10-in. stroke, and a fire-pump with a capacity of 100 gallons per minute.

The suction pipe for each main pump has an inside diameter of 20 ins. It leaves the pump by a reverse curve, and passing out through the hull, terminates in a flattened nozzle or suction head 10 ft. wide and 20 ins. high, inside measurement. The suction pipe is made of ¼-in. steel and the suction-head of ⅝-in. steel is curved vertically with a radius of 13 ft. Within the suction-head are placed six screen-bars of ¼-in. steel plate. The radial joint of the suction pipe is made of a stuffing-box of cast-steel, fitted with rubber packing rings, a 20-in. radial pipe of cast-steel sliding in the stuffing-box and the flange piece of cast-steel, riveted to the suction pipe and fitted with heavy lugs joining those on the stuffing-box, and all connected by a 3-in. steel pin passing through the lugs.

Underneath each suction pipe is an 8-in. pipe for the water-jet, connected at the pump end by 9 ft. of 8-in. rubber hose. Under the suction-head this pipe divides into three branches terminating in 1½-in. bronze nozzles. As shown on the drawings on our inset sheet, these suction-pipes are stiffened by hinged braces and are hoisted by tackle suspended from the A-frame spanning the forward end of the well. They are held in any required position by a suspending bar, which passes from the top of the suction-head to the supporting brackets on the forward box-girder.



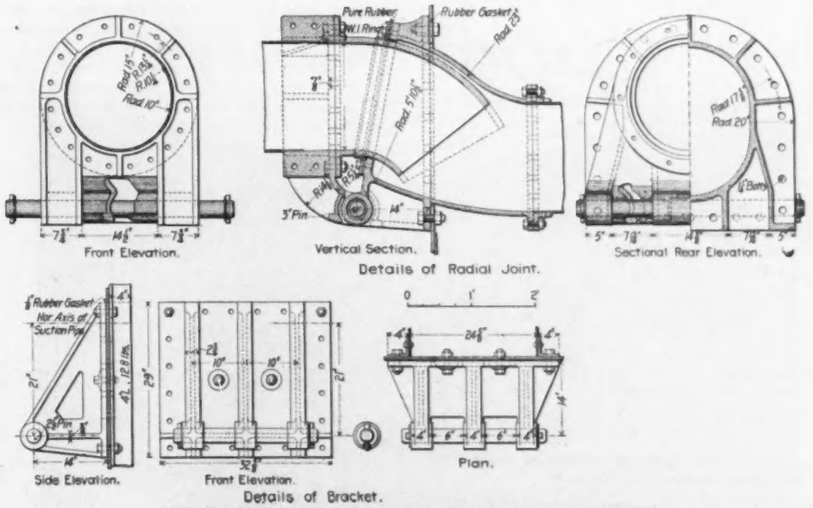
SWIVEL JOINT FOR DISCHARGE PIPE.

There is one 24-in. discharge pipe for each main pump, with all straight portions made of ¼-in. tank steel and the curved parts and flanges made of cast-steel. This discharge pipe leaves the pump by an enlarging pipe, and making a quarter turn with a radius of 4 ft. 9 ins., it passes down and directly out through the stern of the dredge. At the stern is a reverse-curve swivel joint, by means of which the pipe beyond the dredge is slightly raised and can be changed in direction through an angle of 180°. Outside of the dredge the discharge pipe is divided into lengths of 24 ft., each length fitted with flanges and connected with the adjoining lengths by a coupling and piece of flexible rubber hose, 3 ft. 8 ins. long.

At every 25 ft. this pipe is supported upon steel pontoons, so arranged that they may swing under the pipe and present their narrowest dimension to the current. Each discharge pipe has a total length of 500 ft. and is connected to the dredge by 5 ft. 8 ins. of rubber hose and ends in a baffle-plate intended to steady the pipe while material is going through it. The pontoons are made of 3-16-in. tank steel, riveted to suitable frames and angles, and are provided with a chair for holding the pipe. The flexible hose employed is made of 8-ply best Para rubber, with an interior lining of ¼-in. of pure rubber and the ends are capped with rubber so that no cotton threads are exposed. This rubber hose is 25-in. interior diameter and is secured to the pipe and swivel-joint by wrought-iron bands.

The dredge is operated by hauling on wire cables attached to piles driven in advance of the boat, in such manner as to dig a channel 20 ft. wide on the bottom at each cut. For this purpose two bow winches are placed on the forward deck, each winch having double engines so geared as to wind up at speeds varying from ¼-in. to 7 ins. per second. The drum has a diameter of 42 ins. and a length sufficient to hold 1,200 ft. of ¾-in. wire rope, in two lays. The spud anchor is made of oak, and is 22 ins. square and 36 ft. long, with cast-iron shoe and cap. This spud is to be fitted with hydraulic pipes for sinking and will be raised by steel bands passing around the spud. Mooring piles of wrought-iron tubing are also provided; six of these being 10-in. diameter and ten 7-in. diameter. An auxiliary vertical boiler supplies steam for the electric light engine, fire pump and shop engine, so that these may be used when the main battery of boilers is out of service. The electric light plant includes an engine, dynamo, two 2,000 c. p. arc lights, one 4,000 c. p. focusing head-light with reflector, 75 16 c. p. incandescent lamps, and the necessary switchboard wiring and fixtures.

A marked departure in the specifications for these dredges is found in the efficiency tests demanded of the contractor. This test extends over ten days of 24 hours each and acceptance depends upon the percentage of lost time due to defects of the machinery when compared with the actual time available for dredging. This test must be made under the actual conditions of every-day work; and for this purpose the dredge must be run to its full capacity and deliver its material through the full length of 500 ft. of discharge pipe, with all the movements of the dredge and the selection of place under the control of the Engineer Officer in charge, or his appointed agents. During the test, at which the contractor may be present, an accurate log is to be kept of the operations of the dredge, recording the starting and stopping of pumps, and the cause for the same, time consumed in towing and mooring, moving position, etc. With these deductions made from the "ten days" the remainder shall be regarded as "available dredging time," which shall be used as a basis for de-



DETAILS OF RADIAL JOINT AND BRACKET FOR SUCTION PIPE.

termining the percentage of "lost time" due to stoppage of any part of the machinery or plant subject to contract. During this whole period of 10 days of 24 hours each, the "lost time" must not exceed 12½% of the "available dredging time," under penalty of non-acceptance of the dredge. If defects are remedied, another, but only one other, test can be ordered; and if the dredge finally fails to meet the contract requirements, the right is reserved to either reject it or accept it at such a reduction in price as may be determined by the Engineer in Charge. The dredge and its appliances is to be delivered ready for test at Cairo, or at St. Louis, within six months from the date of the notification of approval of contract, under a penalty of $150 per day for each day of delay, unless this delay is occasioned by freshets, ice or other accidents, against which ordinary foresight can not provide.

THE FAILURE OF THE MELZINGAH DAMS OF THE FISHKILL & MATTEAWAN WATER CO.

The most notable dam failure for some time past occurred early on the morning of July 14, as noted briefly in our issue of July 15. Two earth dams, with masonry heart-walls, were carried away at the end of a storm, causing the loss of seven lives and damaging some property. The dams formed two small reservoirs close together on a small mountain stream and were a part of the water-works system supplying Fishkill and Matteawan, N. Y. Two members of the staff of this journal visited the scene of the accident on July 16, provided with a camera, tape measure, hand level and compass. An eminent hydraulic engineer happened to visit the break at the same time and co-operated with our representatives in the study of the disaster. The result of the investigation made on the spot, supplemented by information since obtained from a variety of sources, is set forth below.

The location of the dams is shown on the map, Fig. 1, prepared from the sectional maps of the New York Topographical Survey, made jointly by the U. S. Geological Survey and the State of New York. The water surfaces of the two reservoirs were about 360 and 380 or 385 ft., respectively, above the Hudson River. The capacities of the reservoirs, as reported for "The Manual of American Water-Works" for 1897 by Mr. E. H. Sheaff, Superintendent of the Fishkill & Matteawan Water Co., were 8,000,000 gallons for the lower, and 10,000,000 gallons for the upper one. The lower reservoir was built when the works were constructed in 1886-7. It immediately proved inadequate and in a year or two the second one was built. Within the last few years a third reservoir, known as the Beacon Hill, has been added. Its location is shown by Fig. 1. This reservoir has a capacity of about 100,000,000 gallons, and is formed by a masonry dam. It is now being used to supply Fishkill and Matteawan with water, or rather a small intake reservoir on the stream below is being used for that purpose, the natural stream flow after the recent rains making it unnecessary, as yet, to draw from the large reservoir, according to the officers of the company. The combined population of Fishkill and Matteawan, by the last census, was 8,000, but there were only twelve miles of mains and 600 taps in use July, 1896, according to Mr. Sheaff's report for the "Manual," mentioned above.

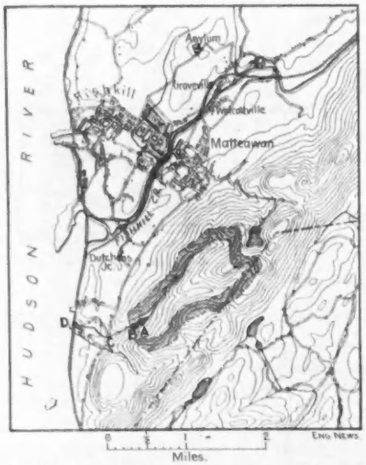


Fig. 1.—General Map Showing Location of Dams That Failed. Contours 100 Feet Apart.

Hatched area shows Melzingah Watershed; A, upper dam; B, lower dam; C, road crossing stream; D, outlet of stream at railway.

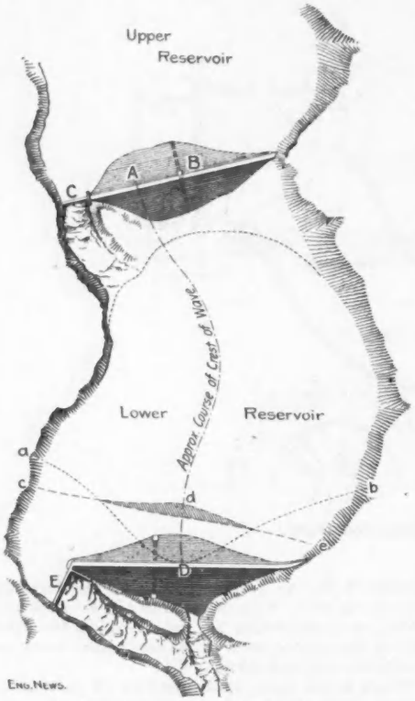


Fig. 2.—Sketch Plan of the Two Reservoirs.

The engineers and contractors for the dams that failed cannot be determined with certainty, and may as well be passed over for the present.

Most of the features of the dams essential for a study of the accident are shown by the accompanying sketches and reproductions of photographs. The general location of the reservoirs, as already stated, is shown by Fig. 1. Fig. 2 is a sketch plan showing the relative position of the two reservoirs, and of the dams and spillways. Figs. 3 and 4 are sketch plans, elevations and sections of the two dams at the parts where the breaks occurred. Fig. 5 is a view from below of the break in the upper dam. Figs. 6 and 7 are views of the break in the lower dam, from above and below, respectively, and Fig. 8 is a view across the break in the lower dam, looking towards the spillway, and showing in detail the outlet pipe, the heart-wall and the character of the earth slopes. Fig. 9 shows the spillway of the lower dam, with vegetation growing upon and above it.

The upper dam was about 340 ft. long and 28 ft. high, and the lower one was about 400 ft. long and 34 ft. high. The heart-wall of each dam came within about one foot of the top of the embankment, and the flow line, with the spillway just ready to discharge, was certainly not more than 1 ft. below the top of the heart-wall in each case.

In other respects the dams also had the same general characteristics. Each was built of earth, mostly sand and gravel, with some clay in the upper one. Each had a thin masonry heart-wall, an upper slope rip-rapped to the water line, or slightly above, and each had a spillway in the natural rock at one side, with a masonry overfall.

Each heart-wall, where exposed, was carried to, but not into, the natural rock, and was built of such small stone as to have the appearance, in the lower parts, of two face walls, filled between with small chips, cobbles and mortar. This is clearly shown for the lower dam by the view, Fig. 8. Cement mortar of good quality seems to have been used in each heart-wall.

The lower dam was not so well constructed as the upper one. The black mold now appears in place beneath the embankment, as do stumps of trees, both beneath the highest part of the dam, the stumps showing plainly in Fig. 8. The material for the embankment of the lower dam was a gravelly loam, apparently dumped in place without an attempt to form layers, and with no puddling. The earth-work of the upper dam shows more clay mixed with the gravel and a better character of gravel, and bears evidence of having been placed more carefully in layers. The difference in the manner of placing the materials was evident in the photographs from which Figs. 5 and 7 were made, Fig. 7 showing no distinct layers, while they were quite apparent in Fig. 5.

The heart-wall of the upper dam was slightly thicker than that of the lower one, but each may safely be termed light, being about 3 ft. thick at the bottom, and from 1 ft. to 1 ft. 6 ins. at top.

The spillway of the lower dam has a greater capacity than the upper, its length being about 70 ft., and its available depth below the crest of the dam about 1½ ft., giving a cross-sectional area of 105 sq. ft. The upper spillway has a length of about 47 ft., and an available depth of 1½ ft., or an area of about 70 sq. ft. Testimony at the coroner's inquest, in progress as this is written, states that the upper spillway originally had a greater depth, having been raised 2 ft. in height several years ago in order to secure more storage capacity. If this statement is correct the original area of the spillway, or overfall, was about 165 sq. ft., against 105 sq. ft. for the lower one. The available depth of each spillway at the time of the flood had been decreased at least 6 ins. by depressions in the dams, evidently caused by settlements at the points of heaviest fills.

Water was drawn from the upper to the lower reservoir through a pipe laid beneath the upper dam. This outlet pipe was controlled by a gate at its upper end, lifted by a screw rod extending down the slope of the inner embankment. The screw wheel at the top of the bank was protected by a small wooden house, shown in the view, Fig. 5.

At the lower reservoir there were gate-houses at the foot of each slope, with a 20-in. cast-iron

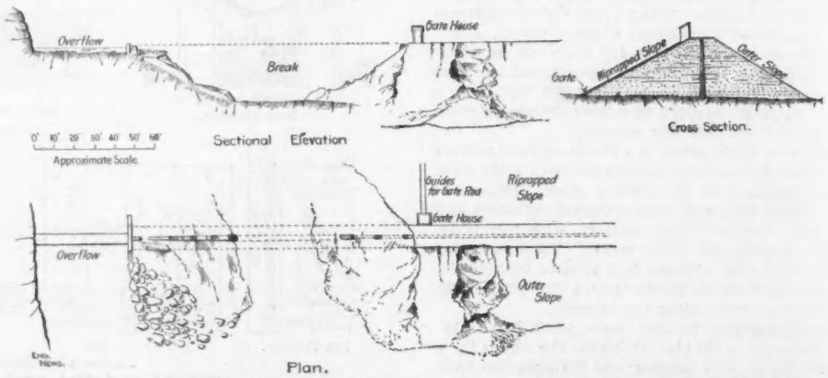


FIG. 3.—SKETCH PLAN, ELEVATION AND SECTION OF BREAK IN AND SPILLWAY FOR UPPER DAM.

pipe connecting them and a 12-in. cast-iron pipe leading from the lower gate-house to the villages, all as shown in the plan, Fig. 4, and the views, Figs. 6 and 7. In Fig. 7 a 20-in. branch is shown in the lower gate-house. The natural inference is that an outlet or waste gate was joined to the end of this pipe for emptying the reservoirs, but whatever closed the branch has been carried clean away.

Fig. 8 shows a broken section of the 20-in. outlet pipe. There was evidence, but not conclusive, of an old crack at this break. The second length of pipe below the break was entirely jacketed with concrete, the end of which shows in Fig. 8, suggesting that a light crack was discovered in this length and that the jacket was put on to prevent future trouble. The outlet pipe, as shown by the view, is blocked up with stone. If the break in the pipe occurred before the failure, the consequent leak may easily have weakened the dam, although, leak or no leak, the lower structure was bound to go if the upper one failed suddenly first.

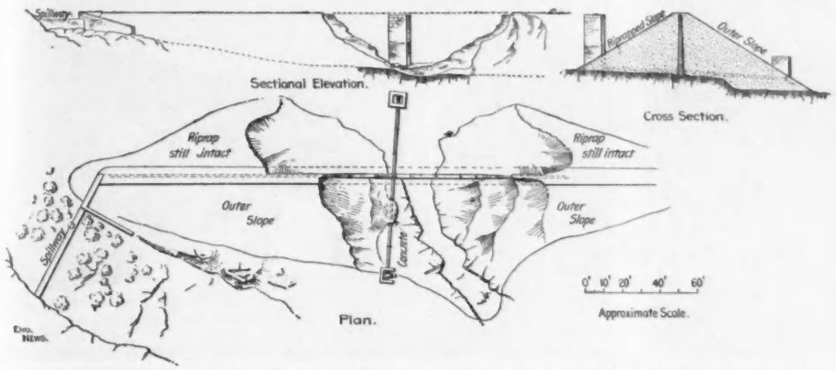


FIG. 4.—SKETCH PLAN, ELEVATION AND SECTION OF BREAK IN AND SPILLWAY FOR LOWER DAM.

The evidence on the ground seems to show that the spillway C, Fig. 2, of the upper dam, had recently been scoured out by an unusual overflow of water; whereas, so little had passed on the spillway E, of the lower dam (Figs. 2 and 9), that willows and other shrubs, and even grasses and herbaceous plants were standing practically undisturbed in the crevices of the rock which formed its bottom.

The failure of the dams probably took place in this wise: The reservoir held by the upper dam was filled to overflowing by the heavy rainfall. For a time the spillway C was able to carry off the flood, but finally the dam was overtopped at A and B, two points on the top of the dam that were slightly depressed below the average level. At B considerable erosion took place (as shown by the view, Fig. 5), while at A a greater volume of water soon washed out the loose earth of the lower slope until the heart-wall was unable to stand the pressure from above, and collapsed suddenly, the water cutting through to bed-rock and completely washing out a section of the dam some 135 ft. long on top. The mass of water, once released, passed at once into the lower reservoir. On account of the narrowness of this basin, the wave was much retarded at the sides, so that a line of particles of water which stood parallel to the top of the upper dam at A, Fig. 2, just before the failure, by the time the foremost reached the lower dam, must have assumed approximately the position, a D b. At the same time the water was much heaped up in the center of the wave in the form indicated by the section, c d e. Thus, when the lower dam was struck by the wave it was immediately overtopped at the point D and failed so quickly that very little water reached the spillway E. The angle at which this lower spillway is placed decreased the volume of wave flow which could go over the spillway, though, for any gradual rise of water in the reservoir this angle would have made no practical difference in the capacity of the spillway.

The capacity of the spillway of the upper dam at the time of the accident corresponded closely with Fanning's figures for spillways for reservoirs on ordinary streams in the New England and Middle States. But this was essentially a flashy stream, as is evidenced by the contour lines shown within the watershed on the small map, Fig. 1. Furthermore, although the area is mostly wooded, the hillsides are rocky and the soil is of a kind not especially retentive of moisture; the area of the whole watershed was about one and one-tenth miles, and its average elevation was probably not far from 1,000 ft. above sea level, and 600 ft. above the level of the upper reservoir; the reservoirs were small and, having steep banks, would rise rapidly. It must be borne in mind, too, that to get a capacity of overflow sufficient for even an ordinary flood under average conditions, the reservoir had to be filled to the very top of the embankment. In other words, the spillway level was only about a foot below the top of the heart-wall of the dam, and only a foot and a-half or two feet at most below the top of the earth embankment, so that to give a discharge of anything more than 200 cu. ft. per sec. the reservoir must have been filled to the point of overtopping the dam itself.

Reference has already been made to the fact that the spillway of the lower dam showed conclusively that but little water had gone over it. The officers of the company corroborate this to a certain extent. Mr. G. E. Taintor, President, and Mr. G. D. L'Hullier, Secretary and Treasurer, both of 11 Wall St., New York city, state that the records of the company show that on June 29, 1897, the water in the lower reservoir was 3 ft. 2 ins., and in the upper one 1 ft. 2 ins. below the respective spillways. Also that water continued to be drawn from these reservoirs exclusively to the time of the accident. From June 29 to the beginning of the storm preceding the accident scarcely any rain fell, so that the reservoirs must each have been low before the storm. In fact, the lower reservoir now shows fresh vegetation far below the water line, with scarcely a sign of having been submerged. It would seem, then, that the upper dam gave way before the lower reservoir filled up, or had been full for more than a short time.

Since the above paragraph was put in type Mr. Taintor informs us that the company's records show that on July 12, the first day of the storm (hour not stated), the water was 7 ft. below the overfall of the lower spillway, and 7½ ft. below the upper one, the gate between the two reservoirs being open.

No rainfall records have been kept at the reservoirs. There are, however, five Weather Bureau stations near by, and in different directions, the observers of which have kindly sent us the rainfall at their stations during May and June, and for July to the end of the storm, with some details of the storm itself. The elevations of three of the stations above sea level, with their directions and distances from the reservoirs, are approximately as follows: Wappinger's Falls, nine miles to the north, at an elevation of 100 ft.; West Point, across the Hudson River, six miles to the south at an elevation of 160 ft.; and Carmel, in the Croton drainage area, some 17 miles southeast, at an elevation of about 500 ft. In the Croton drainage area records are also kept at two other points, Boyds and South East reservoir, and copies of these records have also been furnished us. The average elevation of the drainage area in question has already been given as about 1,000 ft.

The communications sent us by the three observers are as follows:

Wappinger's Falls, N. Y., July 19, 1897.

Dear Sir:

Total rainfall, in inches, for May	3.72
" " " " " June	4.55
" " for July to the end of storm on carly morning of July 14	5.82
Total rainfall for storm ending July 14, 5 a. m.	5.64
" " from 11 p. m., July 13, to 5 a. m., July 14	1.81

The rainfall by hours I cannot give, but the heaviest rainfall was about midnight.

Henry C. Townsend,
Observer.

Carmel, N. Y., July 19, 1897.

Sir: In answer to your communication of the 17th inst., I can furnish you the following information as to rainfall, in inches, at our stations:

	Boyd's reservoir.	S. E. reservoir.	Carmel.
May	5.56	6.03	5.26
June	3.41	3.18	3.23
July to end of storm at 6 a. m. July 14.	4.80	4.93	9.70
For the storm ending 6 a. m., July 14..	4.26	4.26	4.61
At Carmel, from 8 p. m., July 12, to 6 p. m., July 13.			2.25
" " " 6 p. m., July 13, to 6 a. m., July 14.			2.36
			4.61

which would indicate that there was not any violent rainfall about midnight, July 13-14, in the vicinity of Carmel.

FIG. 5.—VIEW OF BREAK IN UPPER DAM, FROM BELOW.
(The break in embankment towards right side of view shows a secondary point where water in reservoir overtopped the dam.)

In order to explain the excess of rainfall at Carmel July 1-14, I would state that on July 2, from 1 p. m. to 2.30 p. m., we had 5.03 ins. of rain, while at Boyd's reservoir the rainfall was 0.45 in. and at Southeast reservoir it was 0.56 in.

Yours truly,
Thomas Manning.

United States Military Academy,
Surgeon's Office, Cadet Hospital.

West Point, N. Y., July 18, 1897.

Sir: In reply to your communication of the 17th inst., I would state that the records for the rainfall requested were as follows:

May, 4.7 ins. June, 3.2 ins. July 1 to 14, 7.45 ins.

At this station observations are made only once daily, at 7 a. m., and in the case of any rainfall during the previous 24 hours, the time of commencement and cessation of same. The storm mentioned was ushered in about 1 p. m. on the 12th inst., with several heavy thunder showers, which followed one another in rapid succession until about 7 p. m. During this lull in the storm a measurement was made of the rainfall, which registered 2.8 ins. Rain was continuous, with varying severity, during that night and throughout the following day. The total recorded fall, from 1 p. m., the 12th inst., until 7 a. m., the 14th, was 6.8 ins. Respectfully yours,

Geo. H. Torney,
Major and Surgeon, U. S. Army.

From the foregoing it will be seen that at none of the stations was there an excessive rainfall during the night that the dams failed. The Carmel record for 1½ hours on July 2, in comparison with the records for the other two Croton stations, suggest what might have happened in the drainage area of the reservoirs the night of the accident: that is, an excessive rainfall confined to a small area. Whether or not this really occurred can only be conjectured.

The loss of life caused by the failure of the dams occurred at the lower end of the stream, a few hundred feet from the Hudson River, where the boarding-house, for the use of employees in the brickyards, and two frame shanties, were located almost in the path of the flood, being near the channel of the stream and not much above the level of its bed. The valley here was quite wide, but a roadway just below the boarding-house formed a low embankment almost across it, nearly reaching the stream channel, which here was close to the north side of the valley. At the Hudson River the railway embankment formed another dam across the valley. A short distance above the boarding-house the valley was constricted by ridges of rock and earth jutting out from each side.

About half way between the Hudson River and the reservoirs, both in horizontal and vertical distance, a highway crossed Melzingah Creek, the latter being spanned by a bridge some twelve feet above the bed of the stream. Below the bridge the stream dropped precipitously over rocks to the more open valley below, as shown by Fig. 10, which is a view looking down the stream from the roadway south of the site of the bridge. Fig. 11 is a view from about the same point looking across the stream towards the north, and showing the remaining abutment. Just above the bridge and roadway the valley widened out very considerably for some distance upstream, while from the head of this expansion of the valley up to the dams the stream was in a narrow ravine with rugged bed and precipitous sides.

When the flood came down from the broken dams, after passing through the narrow ravine last mentioned, it reached the obstruction formed by the first roadway. Back of this a reservoir was formed, the roadway holding firm until the water reached a level of 8 or 10 ft. above its crest. The water which escaped through the bridge opening and over the top of the roadway passed on down the steep rocks below; spread out somewhat above the ridges of rock and earth spoken of as being just above the boarding-house, which obstructions, finally giving way, caused the first abnormal rise of water spoken of by the survivors of the accident. This rise washed out the roadway near the houses and, carrying out the frame shanties, made a new channel through the brickyards, thus causing the water to run off in two forks with a strip of higher ground between them. Upon this strip the people from the boarding-house, which was still left standing, took refuge.

Meanwhile, the water escaping from the temporary reservoir, formed back of the roadway (at C, Fig. 1), having attained so great a depth, soon washed out the lower side of the roadway embankment (see foreground at Fig. 11), and bridge and road together gave way, suddenly releasing the very considerable body of water which they had held back.

This mass of water passed almost as a wave over the course above described, and was doubtless the cause of the second and greater rise of water spoken of by the eyewitnesses, which carried away the boarding-house and the railway roadbed and, by creating a panic among the persons standing on the strip of land between the forks of the stream, occasioned the loss of life.

FIG. 6.—VIEW FROM ABOVE.

FIG. 7.—VIEW FROM BELOW.

VIEWS OF BREAK IN LOWER DAM.

LAKE SUPERIOR MEETING OF THE AMERICAN INSTITUTE OF MINING ENGINEERS.

The seventy-third meeting of the Institute was held in July in the copper and iron regions around Lake Superior, affording an opportunity of visiting many places of more than ordinary interest. A large party from the east met at Buffalo, N. Y., and left that place July 9 on the steamer "Northwest," of the Northern Steamship Co., one of the two large passenger steamers running between Buffalo and Duluth. On July 12 the steamer arrived off Houghton, Mich., and the party was taken off by two tugs, and then transferred to a barge, which was towed by the tugs to the great copper smelting works. In the afternoon a visit was paid to the stamp mills at Tamarack, and in the evening there was a business session, at which papers were presented dealing with the matters of interest in the locality, and including one by Prof. M. E. Wadsworth on "The History and Purposes of the Michigan School of Mines."

On July 13 visits were paid to the Quincy and Atlantic copper mines. At the former about 24 persons descended at a time in a large cage having several floors and running down an inclined shaft. In the afternoon the party was given a reception at the Michigan School of Mines, and in the evening there was a reception at the club. After this reception the party boarded the sleeping cars of a special train, and reached Duluth about 8 o'clock a. m. on July 14, leaving again for the Vermilion iron range at 8.30 over the Duluth & Iron Range R. R. A stop was made at Two Harbors to inspect the railway company's locomotive and car shops, and also the ore docks, as all the ore brought down by this road is shipped at this point. The enormous twelve-wheel locomotives (among the heaviest in the world) and the 25-ton ore cars of this road have been illustrated and described in Engineering News. All these cars have air brakes and M. C. B. couplers, a few have tubular frames and a few have Fox steel trucks. A

FIG. 8. LOOKING NORTHWARD AT BREAK IN LOWER DAM, SHOWING OUTLET PIPE, HEART-WALL AND EMBANKMENT.

train load is from 20 to 26 cars, according to the class of engine. The road has a well built and substantial track, laid with 80-lb. rails, very different from what is usually met with on a mining road. It was evidently recognized from the first that in view of the very heavy traffic expected it would be economy to build a heavy track and so save maintenance expenses. The grade is entirely with the loaded haul.

At Tower, 94½ miles from Duluth, the train was switched onto the branch leading to the mines of the Minnesota Iron Co., and the party spent some time inspecting the open cuts and the underground workings. The Vermilion range was the first to be developed on a large scale, and at the Minnesota mines the ore occurs in lenses of very hard hematite, dipping about 70° to the north and slightly to the west. The ore was discovered about 30 years ago, but the first shipments were made in 1884, and in 1886 the mines and railway were acquired by the present Minnesota Iron Co. It had been intended to go on to Ely, 21 miles farther, to see the great Chandler mine, but owing to delays it was decided to abandon this part of the trip. In the evening a session was held in the public hall at Tower, at which the following papers were read: "Development of the Lake Superior Iron Industry," by D. H. Bacon; "Mining Methods on the Mesabi Range," by C. E. Bailly; "Explorations on the Mesabi Range," by E. J. Longyear. The party spent the night on the train at Tower.

On July 15 the train left Tower early in the morning, reaching Bewabik, on the Mesabi range, about 8 a. m. Here an hour was spent in watching the open pit working of the Biwabik mine where steam shovels are now working on three levels, loading the ore directly into the railway cars. The next stop was at the Fayal mine, which has underground workings. The levels are about 12½ ft. apart, and when a room is cleared a vertical shaft or "raise" is driven upward, and the posts are blasted out, allowing the ore to cave in from above. Some of the workings have square sets, while others have "saddlebacks" or sloping roofs, making a triangular drift all heavily timbered. The ore is fairly uniform in quality. Access to the various levels is by means of vertical ladders. Blasting is done by each gang whenever it is ready, there being no set time. The train then proceeded to Eveleth, passing the Adams and Colquet mines, also operated by underground workings, and then to the Auburn mine, which is operated on the milling system, and looks like the crater of a huge extinct volcano. The ore is black and almost like a coarse powder. After stripping the surface earth to uncover the ore, an inclined shaft was sunk from the surface, and this has drifts running into the ore. From each of these drifts "raises" or vertical shafts were carried up to the top of the ore, and through these the ore is passed down through hoppers into the cars in the drifts, which are then run to the shaft and hoisted to the surface, where the ore is dumped into the railway cars alongside the shaft house. The whole of the great crater-like opening is therefore filled with the smaller craters or funnels of the "raises."

From the Auburn mine the train went on to the Franklin mine, and the party walked about 1½ miles to Virginia City, inspecting the workings of the Franklin and Notman mines (milling system), and the open-pit working of the Oliver and other mines, where, as at Biwabik, the steam shovels load the ore from the pit directly into the railway cars, the excavation being carried on at different levels. The train then proceeded to Mountain Iron, and the party walked the whole length of the Mountain Iron mine, which is an open-pit working, but differs from the other mines of this character in being a through cut instead of a pit or basin, the trains of empty cars entering at one end of the cut, stopping to be loaded at one of the steam shovel tracks, and then passing out at the other end of the cut. In some places the ore extends right up to the surface of the ground. Iron ore in this range was first discovered at Mountain Iron in 1891.

It had been intended to go on to Hipping, but in view of the delays caused by the inspection of so many interesting points, and of the fact that many of the ladies of the party were getting somewhat fatigued, it was decided to return to Duluth. From Wolf Junction the return trip was made over the Duluth, Mesabi & Northern Ry. This road is owned by the Lake Superior Consolidated Co., which owns a number of large mines on the Mesabi range, and also a fleet of ore steamers running from Duluth. On reaching the edge of the hills above the city, before descending to the lake shore, the party had a magnificent view of moonrise on Lake Superior. The headquarters of the party in Duluth were at the Spalding Hotel.

Fig. 9.—View of Spillway of Lower Dam, Showing Vegetation Unharmed.

On July 16 the party spent the morning in viewing the points of interest about the city, including the incline railway (for wagons and carriages as well as pedestrians) to Duluth Heights, the lake shore (with the laying of the 42-in. steel main of the new water supply) and Minnesota Point, etc. In the afternoon there was a carriage drive to points of interest, including the Boulevard, a fine parkway built along the line of an old beach high up on the hillside. There was also a steamboat excursion about the harbor, stopping at the new Duluth and West Superior bridge (with a 493-ft. drawspan), the ore docks, coal storage docks, lumber wharves, Merrill & Ring's saw-mills, and the American Steel Barge Works (where the first whaleback steamer was built). In the evening there was a very pleasant reception held at the Spalding, tendered to the Institute by the local committee.

On July 17 about 15 or 20 members of the party left at 10.45 a. m., by the Chicago & Northwestern Ry., for a trip to the Black Hills, of Dakota, and at 2 p. m. the majority left for the east on the steamer "North Land."

THE PANAMA CANAL INTERESTS are at work trying to bring about an understanding between France, England and Germany, having for its purpose the completion of the canal, with locks over the Culebra ridge. The estimated cost is $100,000,000, and it is reported from Washington that an attempt is to be made to induce the United States to join the other nations in the scheme.

BOOK REVIEWS.

THE STREET RAILWAY PROBLEM IN CLEVELAND: A Statement of Existing Conditions and a Discussion of the Policy which the City Should Pursue with regard to its Street Railways.—By William Rowland Hopkins. Vol. I., Nos. 5 and 6, of Economic Studies. New York: Published for the American Economic Association by The Macmillan Co. Paper; 5½ × 8 ins.; pp: 289-576; folding map. Price, 75 cts.

The main features of the street railway situation in Cleveland, where this study was made in 1896, were as follows: By consolidation the number of street railway systems in the city had been reduced to but two, and legislation had just been secured enabling these to consolidate and authorizing the city council to extend the several franchises of the original companies to 1946, or for 50 years, not counting the unexpired terms of the franchises. Prior to this legislation all franchises had been restricted to not more than 25 years and the city had, in some cases, still further limited them to 20 years. Several of the original franchises have been renewed at their expiration and a number have been renewed prior to that time. The companies pay an annual license fee of $10 per car and lay 7 ft. of pavement for single and 16 ft. for double tracks. In a few of the renewals the city has reserved the right to lower the fares, but it has never exercised this right.

According to the author, the street railway companies of Cleveland have always got what they wanted from the city for practically nothing. He fears that the city will extend the franchises for 50 years on the same terms and discusses the proper plan to adopt instead of this.

Municipal ownership Mr. Hopkins regards with disfavor, and presents some strong arguments against it, especially as applied to Cleveland. Service alone considered, the author believes that there is little to be desired in addition to what is now given in Cleveland under the franchise plan. Lowering of fares and compensation for franchises he thinks should be the aim of the city and points out how this may be secured, provided the 50-year franchise extension is not granted.

In the course of the discussion the capitalization, earnings and expenses of the two companies are set forth briefly, and ideas are expressed regarding the compensation rightfully due the city.

Such a study as this ought to set the citizens of Cleveland to thinking. It is also full of suggestions for other localities. If the ideas of the author are correct, the street railway companies of Cleveland are so closely allied with city and state politicians that they can secure anything they desire from either the city government or the legislature, while the attitude of the people at large seems to be one of apathy or helplessness.

In our issue of June 17 we reviewed a monograph on "The Street Railway System in Philadelphia," which described the history and present status of street railways in that city. Mr. Hopkins discusses the street railways of Cleveland more as a problem pressing for solution and in danger of not being properly handled. But at the same time he gives the most essential points in the history of the Cleveland system. The two monographs are a timely addition to the scanty information available regarding street railways from the standpoint of the public. It is to be hoped that other careful investigators will do equally good work for a number of other cities.

YOUNG ENGINEER'S GUIDE.—J. V. Rohan, Racine, Wis. Published by the author. 6 × 4½ ins.; pp. 242; morocco. $1.25; cloth, $1.

The author of this little book is an employee of the J.

FIG. 10.—SHOWING LOWER COURSE OF STREAM. (From C to D on Plan, Fig. 1.)

FIG. 11.—LOOKING NORTH ALONG ROADWAY. (The bridge, south abutment and a considerable length of roadway were washed out by the flood.)

VIEWS FROM ROADWAY ACROSS MELZINGAH CREEK, ABOUT 180 FT. ABOVE HUDSON RIVER. (Point C, Fig. 1.)

I. Case Threshing Machine Co. He intends it especially for the instruction and guidance of young men learning to run engines, and those operating farm engines and small plants, whose experience has been limited. It is writtten principally in the form of a catechism, with questions and answers, and its information is given in simple and compact form, so as to be easily understood by any one capable of running an engine. The book is as good of its kind as any one we have seen.

A TREATISE ON ARCHES, DESIGNED FOR THE USE OF ENGINEERS AND STUDENTS IN TECHNICAL SCHOOLS.—By Malverd A. Howe, C. E., M. Am. Soc. C. E., Professor of Civil Engineering, Rose Polytechnic Institute. New York: John Wiley & Sons. Cloth; 5⅛ x 6 ins.; pp. 351; diagrams and illustrations. $4.

After giving a short history of the arch of stone, wood and iron, Prof. Howe devotes the larger part of his book to the mathematical discussion of the elastic arch, with and without hinges. He gives formulas for practical use for symmetrical, parabolic and circular arches under various relations of load, etc.; compares types of arches, and shows the application of the formulas for vertical and horizontal loads, wind loads, maximum stresses, reactions, bending moment, etc. He specially discusses the St. Louis arch and the spandrel-arch of Mr. Max Am Ende, proposed for a bridge over the Douro. In Chapter XII. the masonry arch is taken up, covering stone, brick and concrete for spans of not less than 25 ft. He commences with a type of masonry arch amenable for calculation by the formulas deduced for the elastic arch, and follows with the general treatment of masonry arches. The effect of lead in the joints and of iron pins at the crown and skewbacks, is noted. Chapter XIII. is devoted to the Alexander and Thomson method for designing segmental masonry arches, showing the close resemblance existing between certain transformed catenary equilibrium curves of Rankine and the circle. The three-point circle is mainly used and the discussion is illustrated by practical examples. Very considerable space is devoted to the valuable series of tests of arches instituted by the Austrian Society of Civil Engineers and Architects in 1895. A large number of tables close the volume, deduced from the formulas given and to be applied with them. Among these tables is one stating the chief features, dates, etc., of masonry arches constructed at various periods, to the number of 108 in all; the dimensions of a number of cast-iron and of wrought-iron and steel arches are also noted, along with their dates and the names of the engineers.

LEGAL DECISIONS OF INTEREST TO ENGINEERS.

Liability of City in the Operation of Water-Works.

When a municipal corporation assumes or accepts powers or duties that are not public in their nature, it is to be treated, in relation to those powers and duties, in the same way as a business corporation or a natural person would be. If these latter had made a charge for furnishing water, and had accepted payment of that charge, the courts would consider that contract to furnish water to the person paying. And if that business corporation, by sheer mismanagement, the employment of incompetent men, and by negligence, had prevented the use of the water it had agreed to supply, when it was most needed, the courts would hold such corporation or person liable for the direct resulting damages.—Lenzen v. City of New Braunfels (Sup. Ct., Tex.) 35 S. W. Rep., 359.

Power to Regulate the Price of Light.

Where the constitution of a state authorizes cities to frame their own charters, and make regulations subject to and not in conflict with the provisions of the general laws, and a general law exists providing for the furnishing of light to the cities, and for the control and regulation of them by the city, the right of a city to regulate the price of light cannot exist unless found in the general law.—Tacoma G. E. Light Co. v. City of Tacoma (Supreme Ct., Wash.) 44 Pacific Reporter, 654.

Patents and Bridge Contracts.

The public is not precluded from using what is deemed to be desirable and necessary for the public welfare because it may be covered by letters patent and a royalty must be paid for the right to use same. Where the royalty to be paid was fixed and certain, and the proposal inviting bids for the building of the bridge definitely stated that the cost of such royalty should be paid by the accepted contractor in a particular way, and all bidders were placed upon an equal footing with respect to the cost of the patent, several bids were actually made, and the contract was let to the lowest bidder, the court held that there was actual competition for the construction of the bridge, and a substantial compliance with the law requiring the letting of the contract to the lowest bidders.—State v. Dawes (Supr. Ct., Kan.), 45 Pac. Rep., 616.

Powers of Cities Relative to Franchises.

A municipality has not the authority to grant a street railway company exclusive rights in a street, unless such authority is expressly granted by the legislature, or arises by implication so directly as to be equally clear.—Citizens' St. Ry. Co. v. Detroit (Sup. Ct. Mich.), 68 Nown. Rep., 304.

Material Men's Liens on Public Bridge.

As bridges are specially designated by the laws of Washington, as subject to mechanics' liens, those who furnish material for public bridges are entitled to the benefit of a statute of that state, requiring a bond to be given by contractors who do work for a county which, if done for an individual would create a right of lien. And a material man's right of action on such bond is assignable.—Gilmore v. Westerman (Supr. Ct. of Wash.) 43 Pac. Rep., 345.

A PROJECT FOR AN INLAND HARBOR AND TOWN site on Lake Michigan, 12 miles south of Chicago, has been launched by New York and Chicago capitalists. The plans, which were made by Lewis M. Haupt, M. Am. Soc. C. E., include an extensive breakwater, with two entrances, 1,200 and 1,300 ft. wide, and two canals leading to a series of docks, having a dock frontage of ten miles. These docks and canals would be formed by deepening and rectifying Wolf River, the Calumet River and Lakes Wolf and George. The estimated cost of the enterprise is about $6,000,000. Wolf Lake has a maximum width of 1,000 ft., and is from 3 to 7 ft. deep. Some dredging has already been done at the mouth of Wolf Lake by the Knickerbocker Ice Company. The committee pushing the project is headed by Kossuth H. Bell, of the Hammond Packing Company, with A. F. Knotts, of Hammond, as Secretary. In the executive committee the Standard Oil Company and John D. Rockefeller are claimed to be represented.

THE SUEZ CANAL COMPANY presents a report for the fiscal year, 1896, condensed as follows: Gross revenue from the passage of 3,409 ships, aggregating 8,500,000 tons, $15,297,400; from 308,243 passengers, $616,400; making, with some other receipts, a total of $15,991,400. Of the ships, 3,211 passed through by night by the aid of electric light. The average time of transit was 15 h. 53 m., or 25 minutes less than in 1895. Of the 3,409 ships, 2,102 were English, 322 German, 230 Italian, 218 French, 200 Dutch, 71 Austrian, 62 Spanish, 47 Russian, 39 Norwegian, 37 Turkish, 7 Portuguese, 2 Egyptian. Not a single vessel flying the United States flag passed through the canal in the year.

THE RELATIVE COST OF TRANSPORTATION BY railway and canal is thus expressed by Mr. Leslie R. Robinson in a paper on "Mechanical Propulsion on Canals," lately presented to the London Institution of Mechanical Engineers:

Items of cost.	Railway.	Canal.
Maintenance of way	13	0
" " works	7	2.3
Repairs of rolling stock	19	6.
Traction	16	8.
Traffic expenses	30	6.
General charges	15	15.
Interest on capital	100	33.3
Totals	200	70.6

He says that the three principal causes why transport of heavy goods by canal cost only about one-third as much as by rail are the following: On a canal there is no cost corresponding to the wear and tear of rails, ties or track appliances, though the cost of maintaining banks and locks must be taken into account. In canals there is a corresponding saving of the repairs on engines and rolling stock resulting from running on a rigid permanent way. The most important cause for economy on canals, however, is the absence of vibration and the smaller magnitude of the works themselves. The table given is taken from the evidence of Mr. Couder before the Parliamentary Select Committee on Canals.

A JAPANESE CANAL, to connect the Sea of Japan with the Pacific Ocean, is proposed by a company now being organized in Japan. The first canal would be only 26 ft. 8 ins. wide, 22 miles long, and deep enough for the passage of torpedo boats. It would commence at Tauraya, on the Japan Sea, and terminate on Lake Biwako, in the Bay of Curawan; the estimated cost for this section being $1,548,000. The second canal would be 90⅝ miles long, and cost $1,290,000; but the exact route is not given.

THE NEW YORK STATE COMMISSION ON VOTING machines was organized at Albany on July 14, with Mr. Philip T. Dodge, Chairman, and Messrs. Robert H. Thurston and H. de B. Parsons, the latter being secretary. Room No. 13, in the Capital Building, has been devoted to the exhibition and examination of models, and August 10 is appointed for the first official sitting of the Commission for this purpose. Models can be sent to the Commission in the care of the Superintendent of Public Buildings, Albany, and all communications should be addressed to the Secretary, Mr. Parsons.

LEHIGH UNIVERSITY is said to be temporarily financially crippled by the fact that its funds are invested in the securities of the Lehigh Valley Railroad Company, which have paid no dividends for three years. A bill is now before Governor Hastings, of Pennsylvania, appropriating $200,000 for the relief of the institution, and unless this bill is signed it is reported that the university may be compelled to close its doors and await better times. This would be most unfortunate, after 30 years of most useful and active work; and it is to be hoped that some of its many graduates now prominent in business life may yet come to the rescue and give it substantial aid in its present extremity.

THE NATURAL GAS WELL on the Binnings' farm, near Baldwinsville, N. Y., is said to be the most prolific yet found in New York State. It is 2,520 ft. deep and has penetrated 200 ft. into the Trenton rock formation. The force of the gas will lift a weight of 300 lbs. placed over the tube opening, and particles of rock are violently thrown out from the bottom of the well. The well is now being piped to save the gas, as the flow of gas is estimated at over 5,000,000 cu. ft. every 24 hours.

THE START FOR THE NORTH POLE BY BALLOON was made by Herr Andree and his two companions, Strindberg and Fraenkel, from the Island of Tromsoe on July 11. All that is now known is that the balloon, after a narrow escape from being driven against the rocks in Sweerenburg Sound, ascended and was seen moving northward over the flat peninsula of Hollaendernaes. The balloon is provided with sails by which Andree hopes to, in some degree, guide his flight towards Greenland and the North Pole.

THE EXPLORATION OF THE MESAS CLIFFS, of New Mexico, is to be attempted by Prof. William Libby, of Princeton University, says a Princeton, N. J., news item. These cliffs occupy a large area and are about 700 ft. high. The tops are inaccessible by ordinary means, and it is believed that valuable geological and prehistoric discoveries may be made if the top can be reached. Prof. Libby will attempt to carry a line across the top by means of four Eddy kites, now on the ground; and if this fails mortars are to be used for throwing a rocket line. The Mesas lie west of the Sierra Madre Mountains and exceedingly interesting fossil remains have been found at their base.

THE PRICE OF ARMOR PLATE was again brought up in the U. S. Senate, on July 13, and after much discussion it was voted that $300 per ton should be the limit fixed in the General Deficiency Appropriation bill, and not $425 as recommended by the Senate Appropriation Committee. An amendment was also passed authorizing the Secretary of the Navy to make investigations and to receive propositions for the establishment of an armor-making plant and to report at the next session of Congress.

CHEAP HOUSES FOR WORKMEN are being built in Leipsic by "The Society for Building Cheap Houses for Workmen." This society has already built 39 houses, valued at $387,216, and providing 361 lodgings for families and 38 for single persons. As the society only demands 3% returns on its capital, it rents houses on the following terms: Single rooms, $9.50 to $14.25 per annum; apartments of three rooms, from $31 to $38, and of four rooms, $36 to $47. A small garden costs 4 cts. per week additional, and for 5 cts. per day a child will be cared for, including its meals. Rent is payable weekly, and the deficit caused by delayed payments amounts to only 6% on the total receipts. No tenant is allowed to sublet rooms and the proprietor must give a week's notice and the renter three months' notice before changing.

THE MUTUAL BOILER INSURANCE CO. of Boston, Edward Atkinson, President, issues a circular stating that during the past year it met with a loss of $14,000, the sum of all previous losses in 19 years having been only $361.77. The loss, it is stated, occurred from an inherent fault either in the material or in the construction of the boiler "which could not be detected by any of the ordinary methods of inspection of this or any other boiler insurance company." The company has succeeded to the ownership of the records and reports gathered during 1896, by Mr. Atkinson's Steam User's Association, which expired after a life of only about a year, and it is intended to take up a portion of the work contemplated to be done by the Association, such as giving every member "the latest and best information on the subject of steam engineering and practice," advice on the use of mechanical stokers, economizers, and on "new devices" which are so often put before the manufacturers of steam in the expectation of very great economy.

THE PROPOSED LONG-DISTANCE TRANSMISSION power plant, by means of which the Southern California Power Co. expects to supply electric power in Los Angeles, as noted in our issue of July 8, 1897, includes some 18 tunnels, with a combined length of 12,000 ft., the tunnels having a cross-section of 7 x 5½ ft. The contract for all the tunnels, masonry, flume and cement work, aggregating about $200,000 in price for 3¼ miles of work of all kinds, has been let to Mr. E. F. Phelan, of Redlands, Cal., work to be finished by Jan. 20, 1898. The power company has contracted to deliver power to the electric railway company in Los Angeles on a certain date (not stated), with a penalty of $500 per day in case of failure. We are indebted for the above to Mr. J. H. Dockweiler, City Engineer of Los Angeles, who in turn states that he obtained his information, in response to a communication from this Journal, from Mr. Phelan. As stated in our issue of July 8, the contract for the 80-mile transmission equipment has been awarded to the General Electric Co. The water for power is to be taken from the Bear Valley irrigation system. Mr. H. H. Sinclair, of Redlands, Cal., is General Manager of the Southern California Power Co.